The UKCP09 Threshold Detector Manual

Version 1.2.0

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British Atmospheric Data Centre,
UK Climate Impacts Programme

UKCP09 Threshold Detector Manual

Version History

Version number	Author(s)	Date	Comments
0.1	Ag Stephens (AS)	16/09/09	First draft
0.2	AS	21/09/09	Added notes from PN ppt file.
0.3	AS	10/11/09	Taking into account user feedback
0.4	AS	22/11/09	Beginning re-write
0.5	Paul Bowyer (PB)	10/12/09	Full re-write
0.6	AS	08/01/10	Minor corrections: 1. removed outside range examples (we do not allow this option in the UI).
1.0	AS	10/01/10	Minor corrections: 1. removed outside range examples (we do not allow this option in the UI).
1.1	AS	10/06/10	Minor corrections. Added output details for varied length event. Updated screenshots.
1.2	AS, Sophie Millin (SM)	15/06/11	Added more detail on how to interpret the TD outputs and the summary statistics files. See section 4.1.3 and its sub-sections.

Contents

1 Introduction

You have run the UKCP09 Weather Generator (WG), for a 30 year time period, with 100 probabilistic samples, at a daily time step, and you now have a selection of WG outputs. Each run (there are 100) contains a 30-year time series for a set of weather variables as depicted in figure 1. Each WG output contains 100 future climate weather simulations, and 100 'current' (baseline) climate weather simulations as shown in figure 2. Clearly, processing these files to investigate a particular weather event that a user might be interested in (e.g. how often the temperature exceeds 36°c in the future weather simulations and how this compares with the 'current' or baseline (1961–1995) climate, is a non-trivial task. It is in recognition of this fact that the **UKCP09 Threshold Detector (TD)** has been developed. How to use the TD is described in section 3. However, before using the TD it is important for users to understand the terminology used in setting up a TD job.

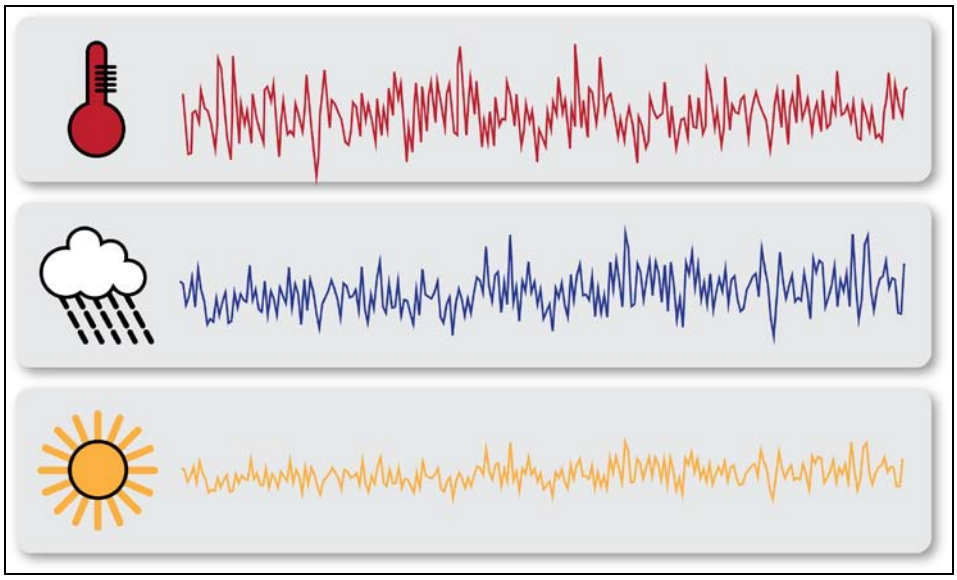


Figure 1. Illustrative depiction of a 30-year time series of multiple weather variables.

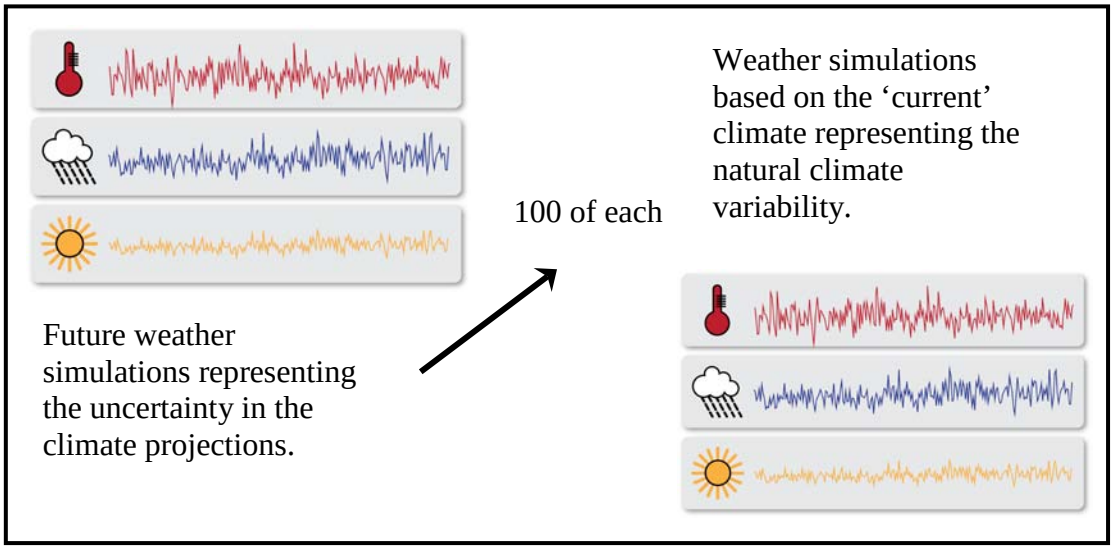
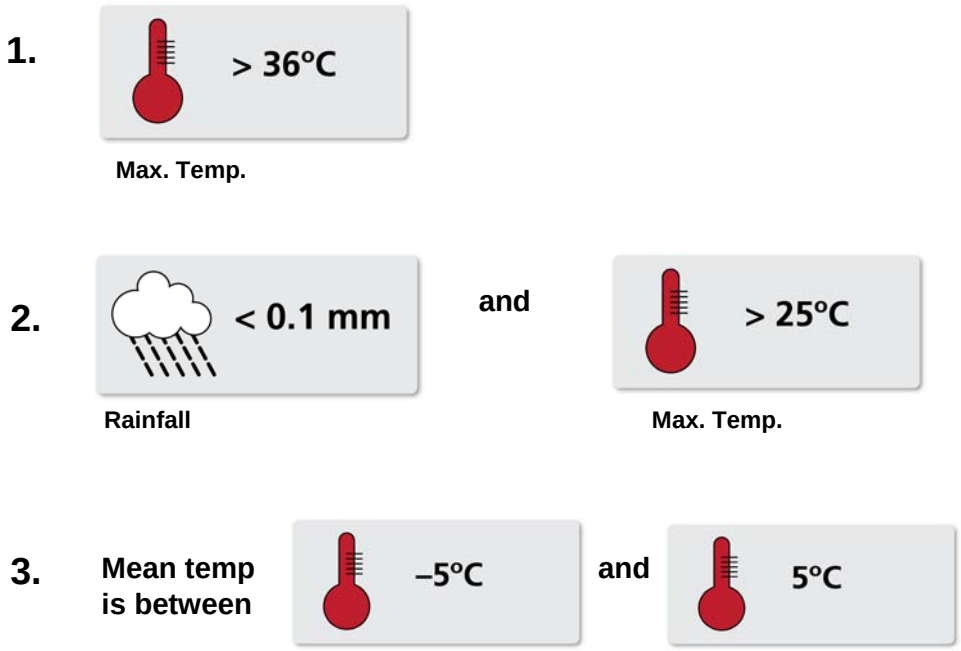


Figure 2. 100 future and 'current' climate weather simulations.

1.1 Threshold Detector Terminology

The name *Threshold Detector* was agreed early on in the project but this manual does not discuss the concept of a *threshold*. It may be more useful to think of this tool as an *Event Counter*. The terminology discussed in this document uses the terms *Weather Condition* and *Events*. Weather condition is defined as follows:

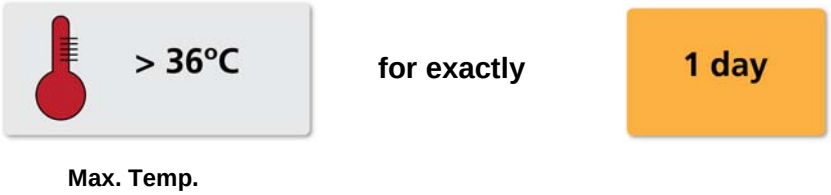
Weather Condition
A *weather condition* is the state of the weather defined by one or two weather variables specified as being either less than and/or greater than a given value. The variable(s) can also be specified as being within a given range defined by two chosen values (see section 2 for more on the capabilities of the TD). Some example weather conditions are shown below:



The TD allows one or two meteorological variables to be defined within a single event.

Event
An *event* describes the temporal duration of the weather condition, in days. A weather condition can last or occur for a fixed (exact) number of days, these are referred to as *fixed length events*; or for greater than a fixed number of days, these are referred to as *varied length events*. The weather conditions shown above are turned into events by adding the duration in the examples below.

1a. Fixed Length Event

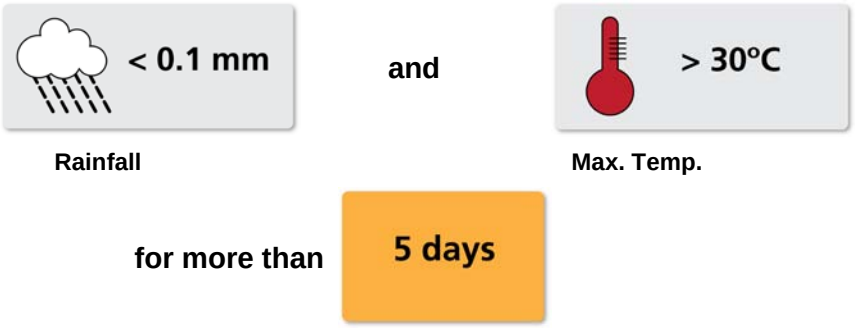


This Fixed Length Event might be useful for railway managers as rails are liable to buckle above 36°c. **Setting the fixed length as one day, records a count of days when maximum temperature is greater than 36 degrees C, per temporal average.** We would expect to see the counts of this event peaking in the June, July, and August months (JJA, or summer months).

1b. Fixed Length Event

This *fixed length event* represents conditions when roads might need to be gritted in winter. The outputs will not include the exceedence, as a range is used in the condition definition (for more details see section 4.1).

2. Varied Length Event

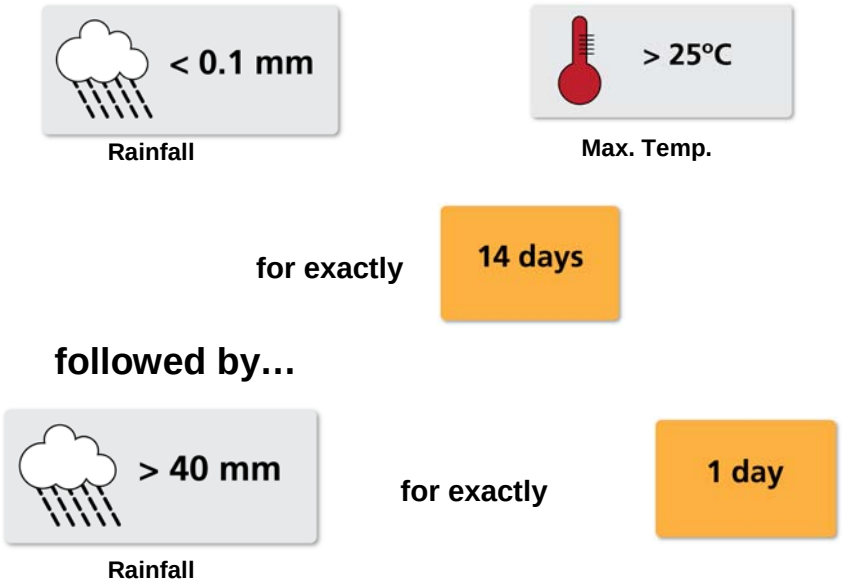


This Varied Length Event represents a sustained period of very hot and dry weather. The outputs (described in section 4.1) **will include the lengths of each event**, as well as the total number of counts per temporal average.

Events are further categorised as *Simple Events* and *Complex Events* which are defined as:

Simple Event
A *simple event* is an event defined by one weather condition and a single duration. All the above examples are simple events.

Complex Event
A *complex event* is one where two simple events are combined such that the first event is subsequently followed by the second, with the constraint that each simple event must be a *fixed length event*. The outputs for a complex event record a count of each event length (up to the maximum duration), and does not record exceedence of the event. The reason for not recording exceedence in complex events is that a given variable can be defined against less than and greater than threshold. A typical example of a complex event would be:



This *complex event* would characterise a fortnight of hot dry weather followed by very heavy rainfall.

2 Capabilities and limitations of the TD

2.1 Constraints on WG jobs

In order to run the UKCP09 TD the WG must have been configured with the following limitations:

- **Frequency: daily**
- **Duration: 30 years**
- **Number of probabilistic samples (or model variants): 100**

Note that the 100 samples can be derived from the following methods available from the UI:

1. Randomly sampling 100 samples.
2. Providing 100 model variant IDs (input via a web form or uploaded from a text file).
3. Sub-sampling the 10,000 samples by 2 variable/temporal average/percentile combinations. Each subset returns 10% of the original population so sub-sampling twice provides 100 samples.

2.2 Weather condition limitations

Each weather condition can only be defined using up to two weather variables (using a logical AND rule, such that the combination of weather conditions is investigated, e.g. hot and wet, cold and dry). This constraint of two weather variables is applied to avoid the user defining highly specific conditions that depend heavily on the inter-correlations between simulated future variables.

Each weather variable can be detected when compared to one of the following rules:

- Greater than a specified value
- Less than a specified value
- Within a specified range of values

The following WG output variables can be used to define events when setting up a TD run:

- Rainfall
- Maximum Temperature
- Minimum Temperature
- Mean Temperature
- Vapour Pressure
- Relative humidity
- Sunshine

Note that mean temperature is not provided as an output variable from the WG. It is in fact calculated from the following formula:

$$\text{Mean Temp.} = (\text{Max. Temp.} + \text{Min. Temp.}) / 2$$

2.3 Maximum event length limitations

The maximum duration that a TD event can last for is hard-coded as 15 days. This is the total duration. In the case of a *complex event* the sum of the durations of the two *simple events* must be less than or equal to 15 days.

Maximum event length for varied length events

If a varied length event runs over the 15 days then the additional days start counting towards a new event. For example:

> If a varied length event with a duration of 3 or more days is found to be occurring for 19 consecutive days then 2 events will be recorded (with lengths of 15 and 4). If the conditions are only detected for 17 days then only one event is recorded (with length 15) as the 2 subsequent days are not long enough to trigger the second event.

Maximum event length for fixed length events

If a fixed length event goes over its total duration then the additional days count towards a new event. For example:

> If a fixed length event with duration 8 is found to be occurring for 16 days then two events are recorded. However, if the conditions are only detected for 14 days only one event is recorded.

2.4 Information about how the TD records events

The TD has no intelligence about the time of year. Users should be aware of the following characteristics of the TD:

1. Events can cross monthly, seasonal, and annual boundaries.
2. The TD stores events in the month that the majority of the event occurred within or that was most central to the event.
3. If an event occurred equally across two months it is counted in the second month.
4. The TD defines its seasons as DJF (winter), MAM (spring), JJA (summer), SON (autumn). Users wishing to use different seasonal definitions can potentially create their own seasonal counts by summing the output for the required months using appropriate software.

2.5 Limitations of the TD

Many events that users may want to detect are beyond the scope of the TD. This section explains these events.

Events with spatial characteristics

As the WG outputs are provided for a single (aggregated) location there is no provision for detecting events with spatial characteristics.

Events with sophisticated temporal characteristics

The TD provides simple counts and exceedence values. Some events are defined by more complex temporal characteristics. An example which cannot be modelled by the TD is identifying the onset of Spring

Overlapping events

The TD only records one event at a time. It therefore has no ability to identify overlaps between events.

2.6 Why do all exceedences not get recorded?

When a condition is defined with a *range* rather than a *greater than* or *less than* rule then exceedence is not available in the outputs. This is because the range can be exceeded both positively and negatively. A positive exceedence of 5 added to a negative exceedence of 5 would result in a cumulative exceedence of 0, and the result is meaningless.

2.7 Data download limitations

The graphics page of the UI usually allows the download of the underlying data to a plot. In the case of TD visualisations the underlying summary data is already available as part of the main outputs so the “Save Data As..” option has been disabled.

3 How to Use the Threshold Detector

3.1 General Approach

The following steps describe the general approach to running the threshold detector. Particular worked examples of running a pre-defined, and user-defined jobs and the various types of event and rules that can be configured, are described in worked examples in section 3.4.

1. Having run a weather generator (WG) job, from the Jobs page of the UKCP09 User Interface (UI), find the particular WG job you are interested in, it will say Run Threshold Detector in the usage options column, as illustrated in figure 3:

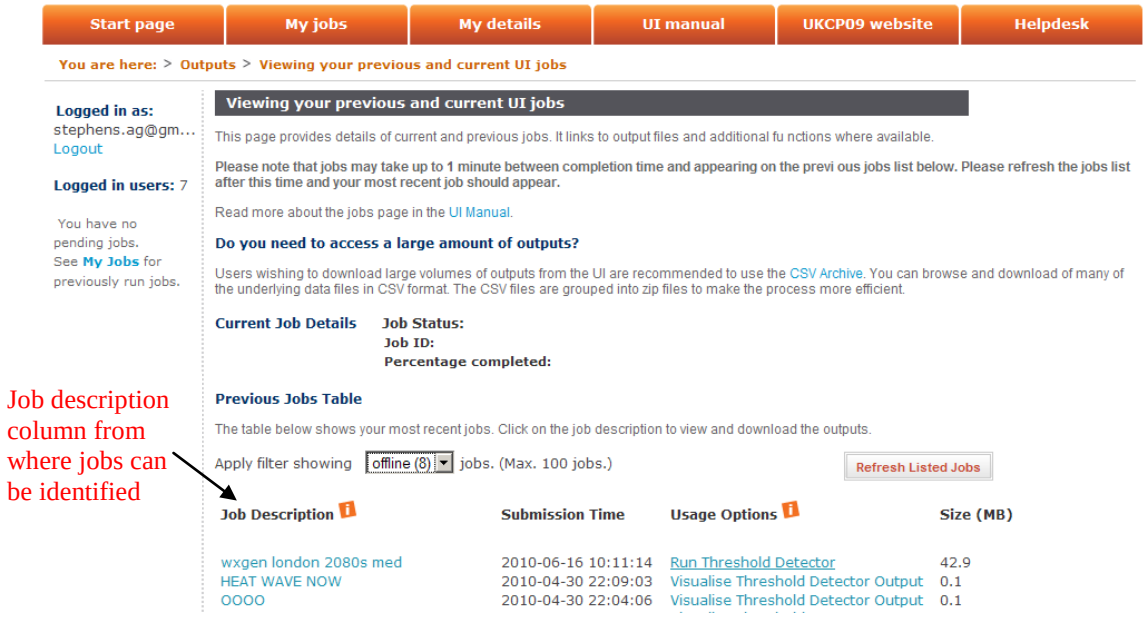


Figure 3. An example showing the Jobs page in the UKCP09 User Interface and illustrating the first step in running a threshold detector job.

2. Clicking on the link Run Threshold Detector on the Jobs page, will bring you to the main Threshold Detector page, where the various different options available can be selected. By default the "Use a pre-defined threshold" is selected, as illustrated in figure 4 below:

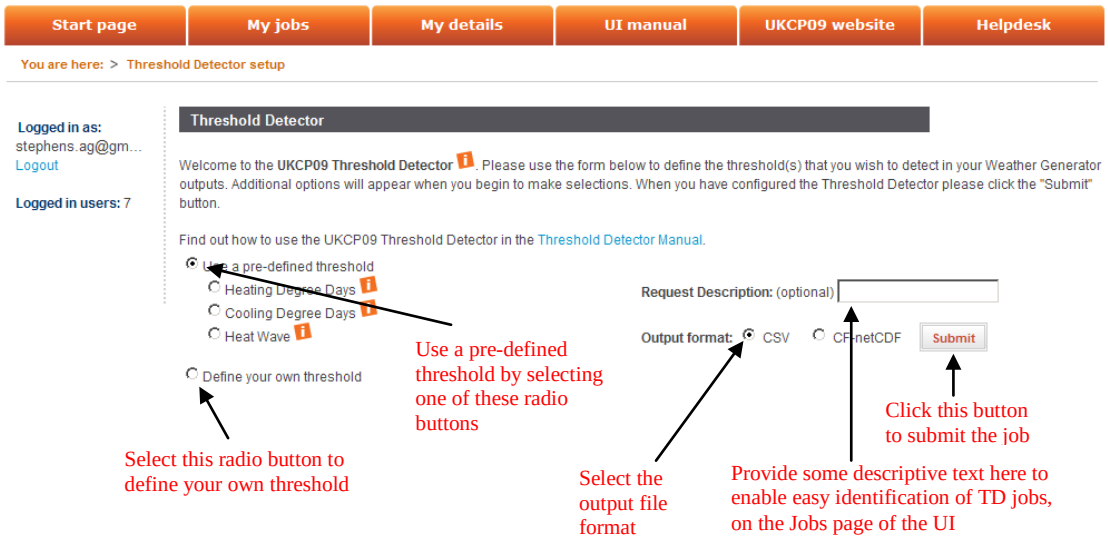


Figure 4. The Threshold Detector start page, from where a user can select a pre-defined threshold, or define their own, and provide descriptive text for the particular TD job.

3. Having defined a threshold by clicking the appropriate radio button, and specifying any other criteria, you may like to provide some descriptive text in the **Request Description** box, such that you can easily identify a particular TD job from the Jobs page, as illustrated in figure 3 above.
4. Once this is done, select the file output format required, as either .csv or CF-netCDF. Now you can submit the job by clicking the Submit button.
5. Once the Submit button has been clicked you will be presented with the page shown in figure 5, **asking you to confirm your submission**, and an estimate of the time to run the job is provided.

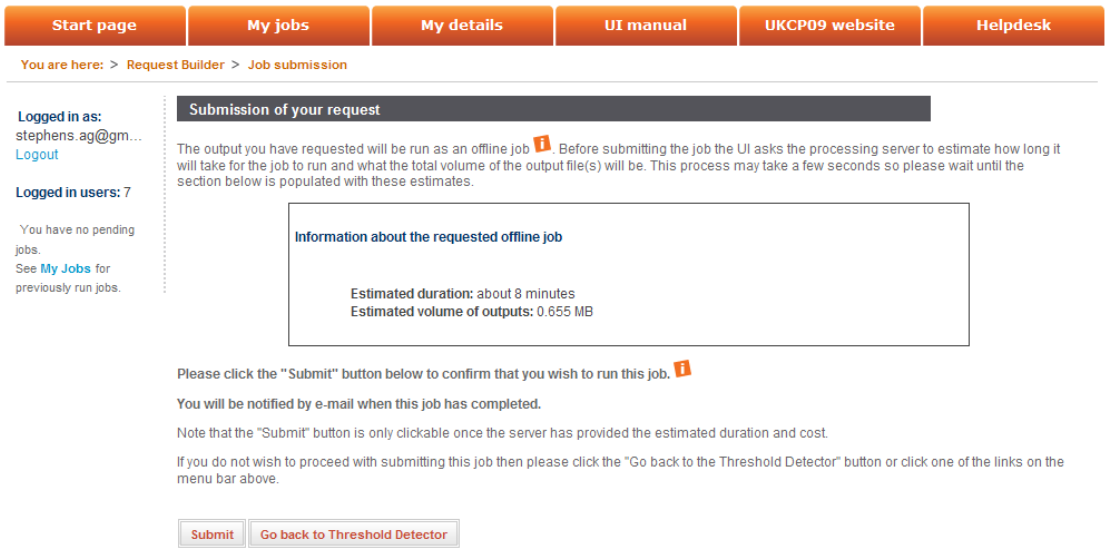


Figure 5. The TD submission page, clicking Submit will result in the job being run.

6. Once the job has been submitted, you will be forwarded to the Jobs page of the UI, and the progress of the TD job submitted will update in the left hand column and main frame of the UI, as illustrated in figure 6 below:

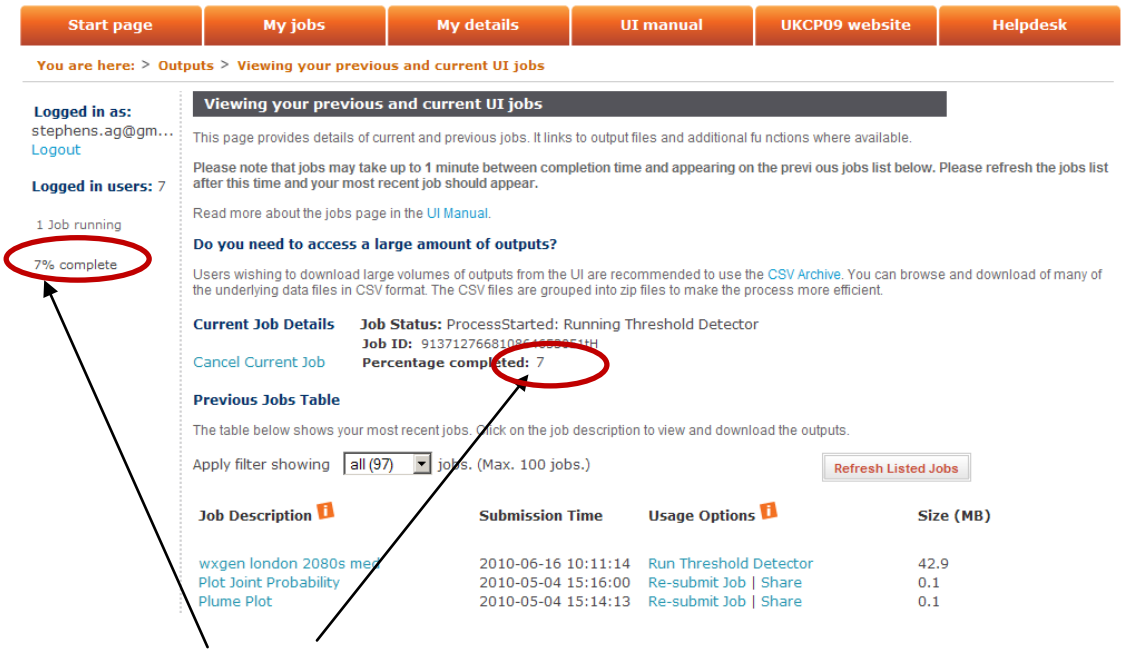


Figure 6. Progress of the TD job, displayed in the left hand column and main frame of the Jobs page on the UI.

7. Once the job is completed, the job will appear in the Jobs page, with the description you gave the job (if any). It is now possible to download the data and visualise the outputs.
8. To download the outputs (for more information on the file structure and contents of the outputs see section 4.1), click on the Job Description link that relates to the particular TD job of interest. Doing so will open a new window which provides a summary of the files that are contained in the zip file that can be downloaded from the link provided in the window, as shown in figure 7 below.

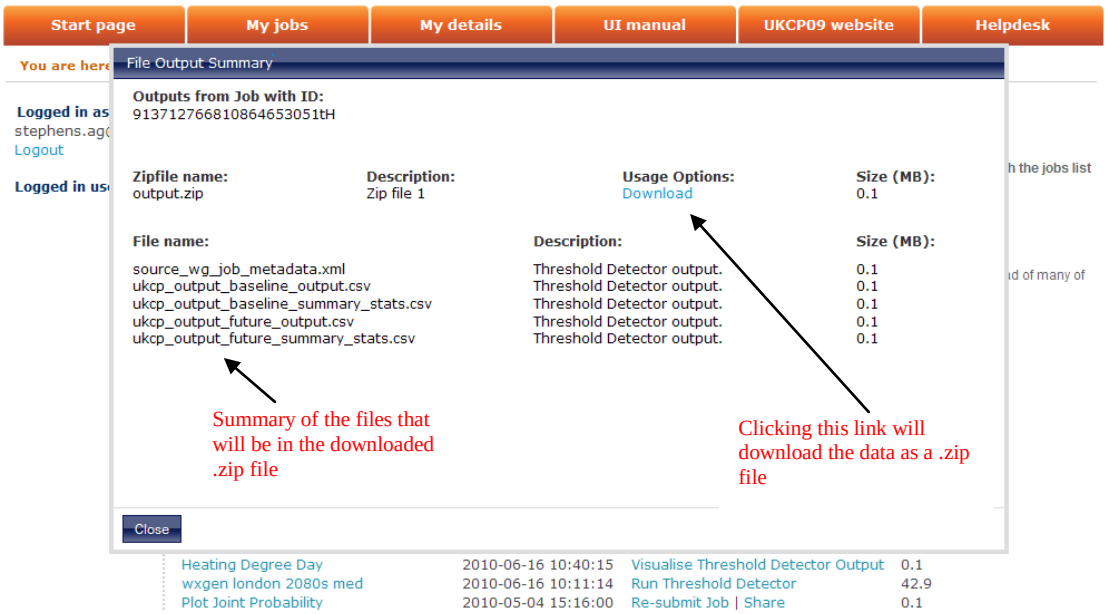


Figure 7. Downloading the TD data.

9. To visualise the outputs click the Visualise Threshold Detector Output link in the Usage Options column of the main Jobs page (see figure 6), and you will be taken to the Viewing and Modifying your output page illustrated below in figure 8. By default, the results are presented as seasonal outputs (for more information on the visualisation of results see section 4.2).

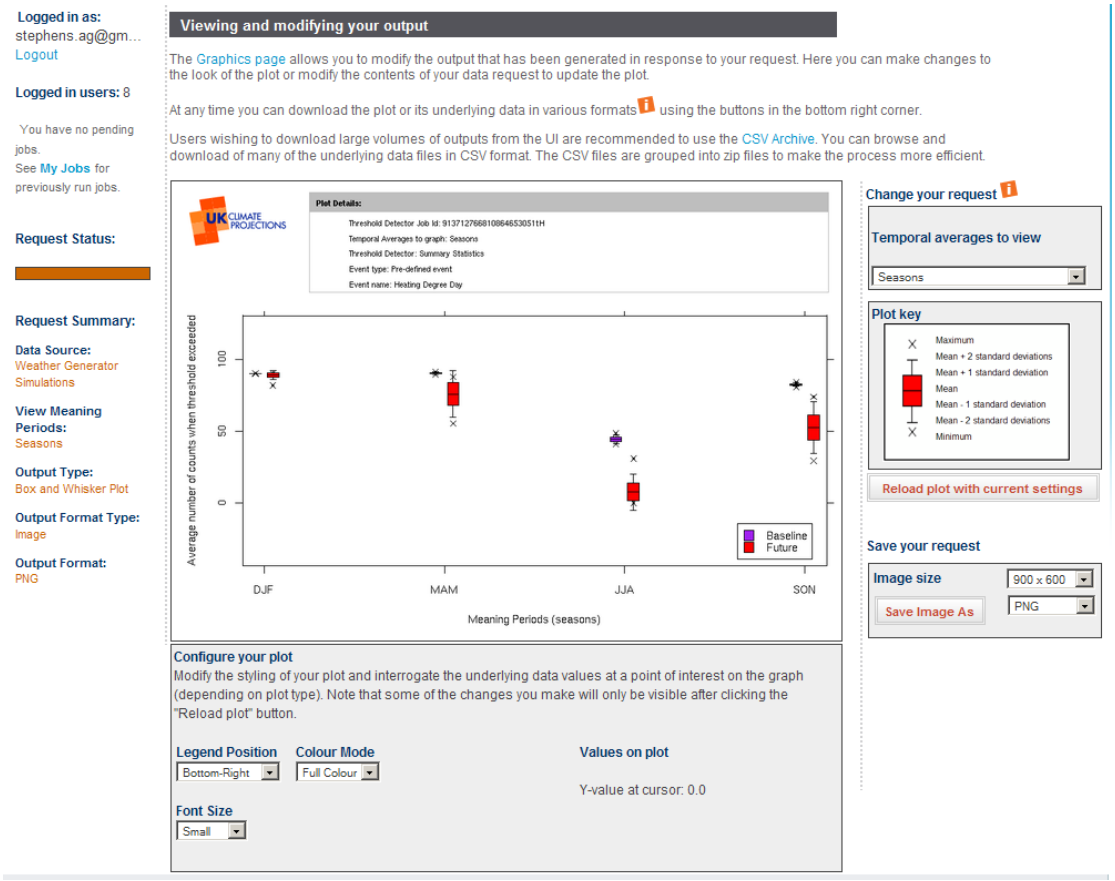


Figure 8. Viewing and modifying graphical output from the TD, in the UKCP09 UI.

3.2 Running a pre-defined threshold

The UKCP09 Threshold Detector provides three pre-defined thresholds that can be investigated, these are:

1. *Heating degree days*: defined as the number of days when mean daily temperature is below 15.5°c, and as such, some form of heating would be required.
2. *Cooling degree days*: defined as the number of days when mean daily temperature is above 22°c, and as such, some form of cooling would be required.
3. *Heat wave*: defined by conditions when maximum daily temperature is greater than 30^{o}c and minimum daily temperature is greater than 15 ^{0}C, for a minimum of three consecutive days.

Running the TD for one of these pre-defined thresholds is straightforward, and is achieved by following these steps:

1. From the main threshold detector page, make sure the pre-defined threshold radio button is selected, and then select one of the pre-defined thresholds, by clicking the appropriate radio button, as illustrated in figure 9 below.
2. Having selected a threshold, you can then optionally provide a descriptive name for the job so that it can be easily identified in your Jobs page on the UI.
3. Then select the output file format for the data, the options are .csv and CF-netCDF. Having selected the desired output format click submit.
4. You will then be asked to confirm the submission, as illustrated in figure 5 above. Doing so will run the job and you will be forwarded to the main jobs page of the UI, and the progress of the TD job will be updated.
5. Once the job has finished processing, you will be able to download the data, and visualise the outputs as described in section 4.1 and 4.2, respectively.

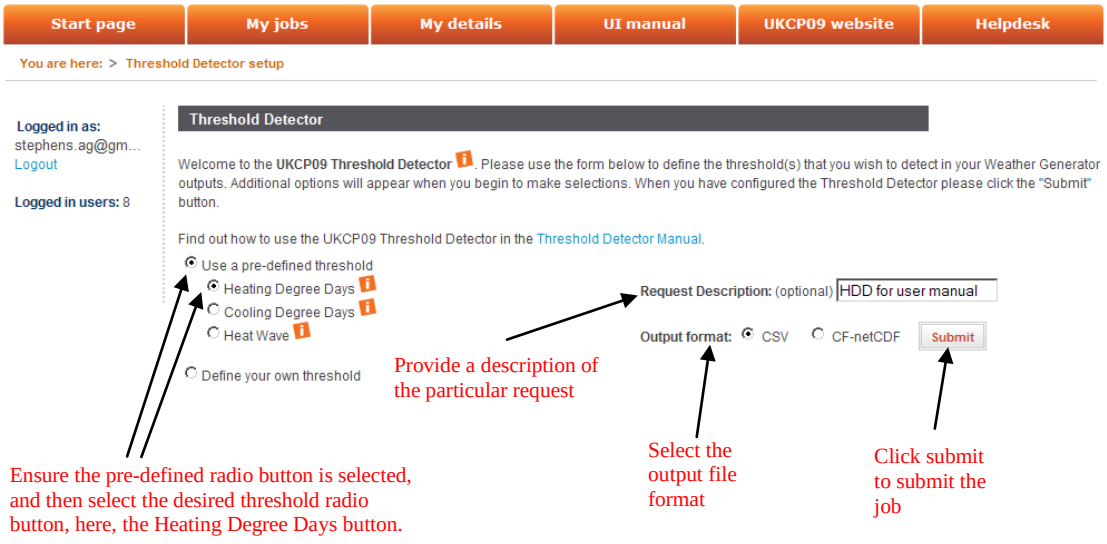


Figure 9. Running a pre-defined threshold detector job.

3.3 Running a user-defined threshold

While the pre-defined thresholds are useful, the TD also provides the functionality to define your own thresholds that are of particular interest for your application. Using the user-defined option, both simple and complex events can be defined, and the following sections will outline how to set up these jobs.

Running a user-defined threshold: simple event general approach

1. From the main Threshold Detector page, click the radio button that says "Define your own threshold", and the options illustrated in figure 10 below, will be presented.
2. A simple event (where one or two weather variables are defined, for a single duration (of either fixed or varied length)), is then constructed by selecting a variable(s) from the drop-down box, specifying what the value of the threshold is and the rule to use - either to be less than, less than or equal to, greater than, greater than or equal to, or within a range, in the appropriate boxes (see the worked examples for more information on how to construct specific jobs).
3. Next, specify the duration of the event, by selecting from the drop down boxes either **exactly** or **a minimum of**, and then specifying the number of days (maximum of 15 allowed).
4. Then provide a description for the request you have built so that it can be easily identified on the Jobs page of the UI.
5. Select the output file format required, and then click submit.
6. You will then be asked to confirm the submission, as illustrated in figure 5 above. Doing so will run the job and you will be forwarded to the main jobs page of the UI, and the progress of the TD job will be updated.
7. Once the job has finished processing, you will be able to download the data, and visualise the outputs as described in section 4.1 and 4.2, respectively.

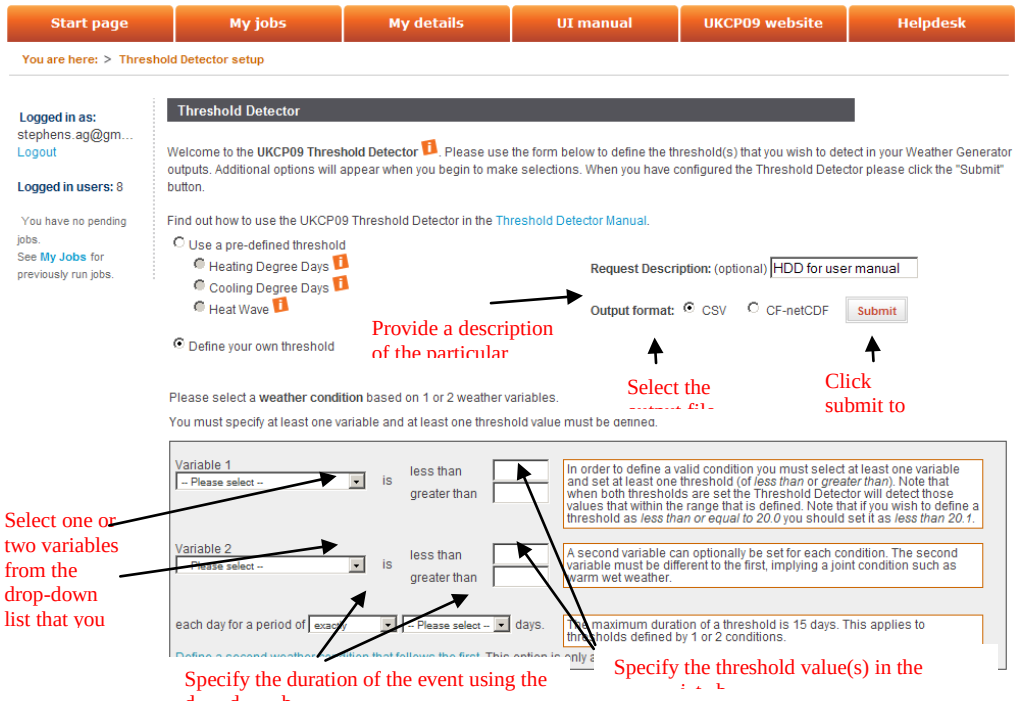


Figure 10. Defining your own threshold, in this case for a simple event.

Running a user-defined threshold: complex event general approach

A complex event is defined as the combination of two simple events with the constraint that each simple event is of fixed duration, and the sum of the durations is not greater than 15 days. To run a complex event, follow steps 1 through 3 as for defining a simple event in section 3.3.1 above, and then do the following:

1. Having set up the first simple event, now click on the link that reads Define a second weather condition that follows the first, as illustrated in figure 11 below:

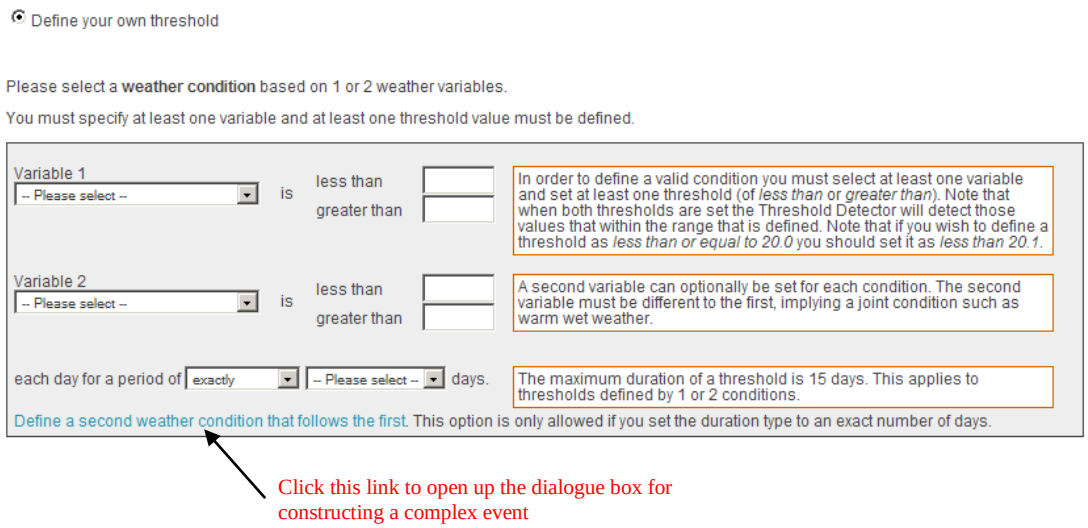


Figure 11. Screenshot of the threshold detector on the UKCP09 User Interface, illustrating the link to click to be able to define a complex event in the threshold detector.

2. Upon clicking the link, a second dialogue box will open allowing you to define a second simple event (of fixed duration), in the same way as the first, as illustrated in figure 12.
3. Then provide a description for the request you have built so that it can be easily identified on the Jobs page of the UI.
4. Select the output file format required, and then click submit.
5. You will then be asked to confirm the submission, as illustrated in figure 5 above. Doing so will run the job and you will be forwarded to the main jobs page of the UI, and the progress of the TD job will be updated.
6. Once the job has finished processing, you will be able to download the data, and visualise the outputs as described in section 4.1 and 4.2, respectively.

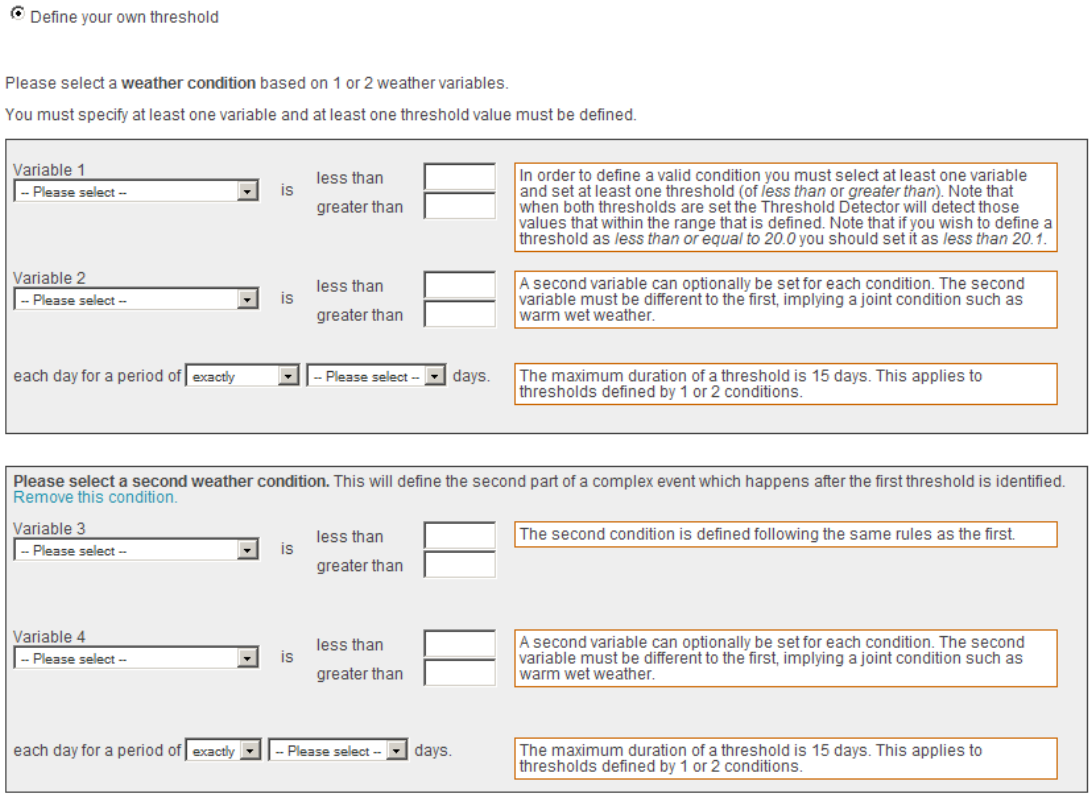


Figure 12. The second dialogue box that is opened, allowing a complex event to be built.

3.2 Worked examples

Having dealt with the general approach to setting up a threshold detector request, a series of worked examples are now presented designed to help users obtain a greater appreciation of the exact workings of particular simple, and complex event, requests.

Simple event worked example: rail lines buckling

When the maximum daily temperature exceeds 36°c for exactly one day (a fixed length event), it is known that rail lines are liable to buckle. The threshold detector could be used to investigate the future occurrence of such events, as illustrated in figure 13 below.

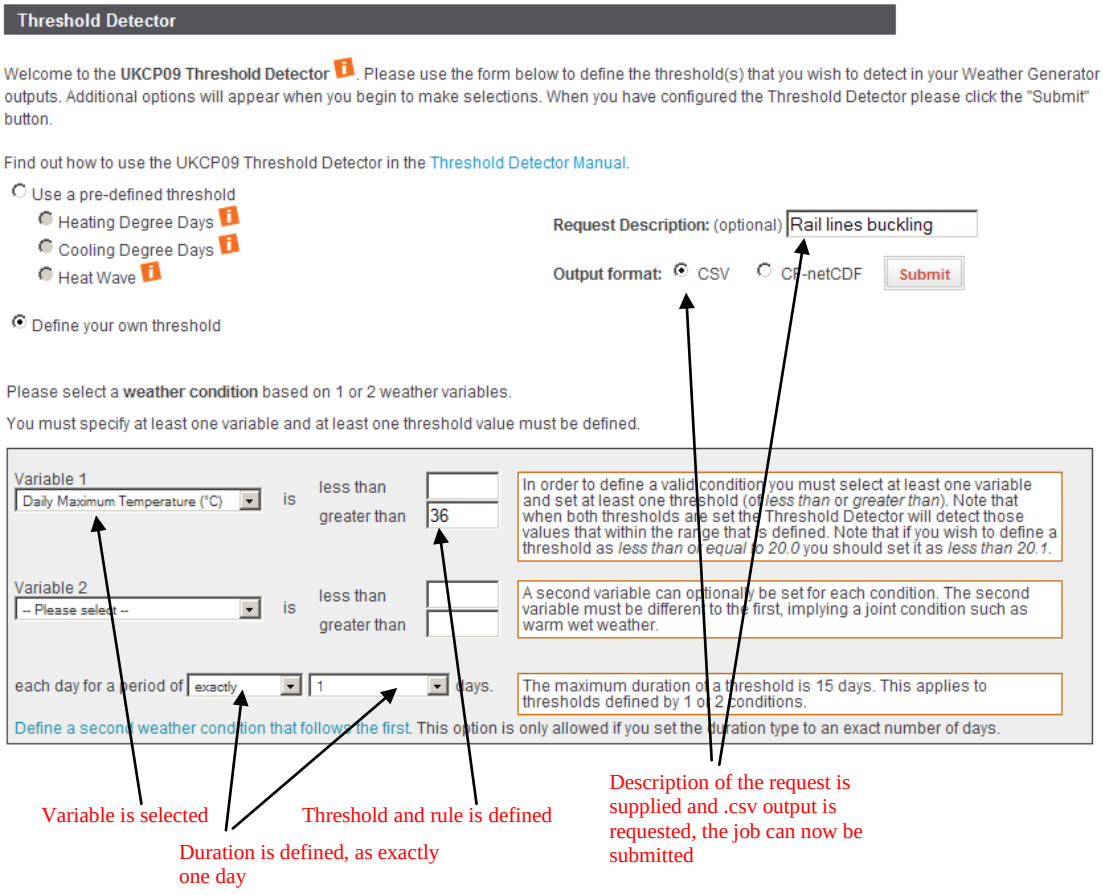


Figure 13. Rail lines buckling, simple event set up.

Simple event worked example: crop irrigation demand

When there has been a period of prolonged dryness, combined with high temperatures a farmer may need to implement some kind of irrigation, to ensure a healthy yield at harvest. These conditions can be specified and changes in the likely need for irrigation in the future, can be investigated e.g. rainfall less than 0.1 mm and maximum temperature greater than 30°c, for a minimum of five consecutive days (a varied length event). This example is illustrated in figure 14 below.

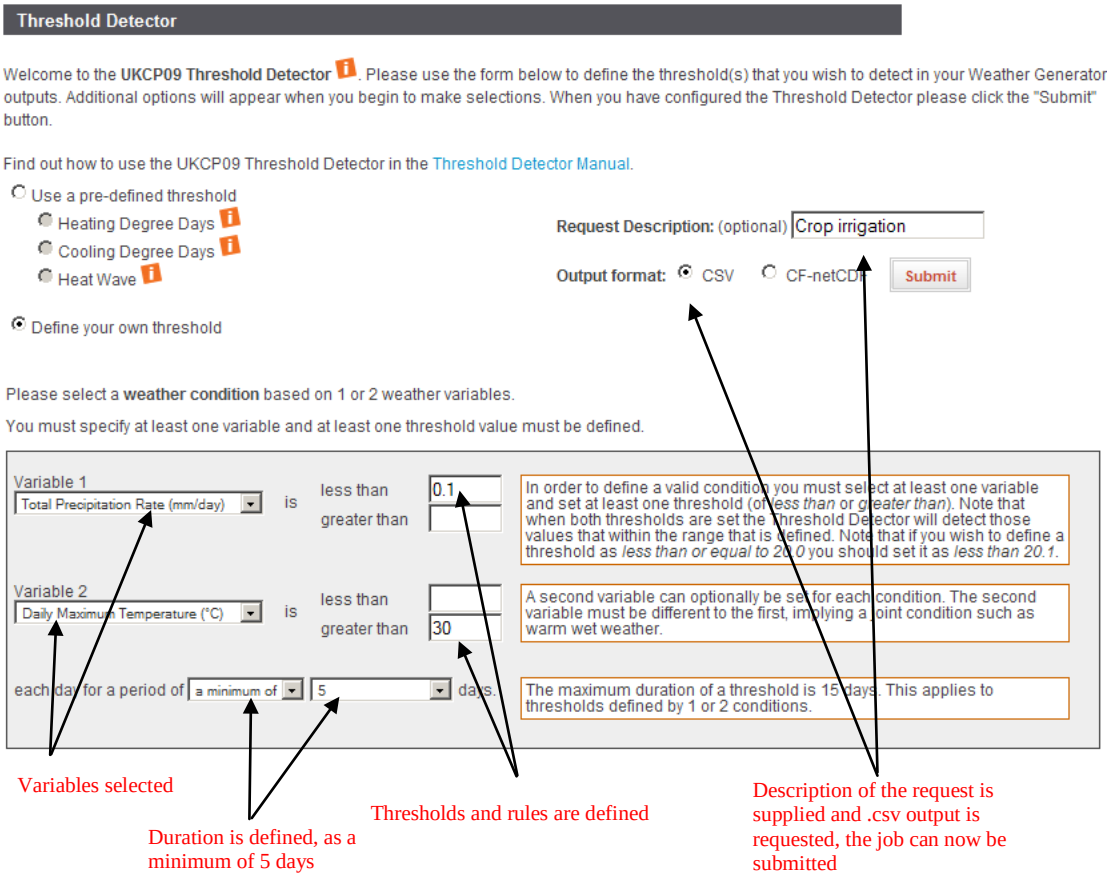


Figure 14. Crop irrigation worked example, another simple event in the threshold detector.

Simple event worked example: gritting roads

In order to maintain safe driving conditions, local authorities may know that when the mean daily temperature is between say -5°c and 5°c for exactly one day, they need to send out vehicles to grit the roads. The TD can be used to investigate how the occurrence of these events might change in the future, as illustrated in figure 15 below. This is an example of using the threshold detector to investigate conditions within a range (inclusive range).

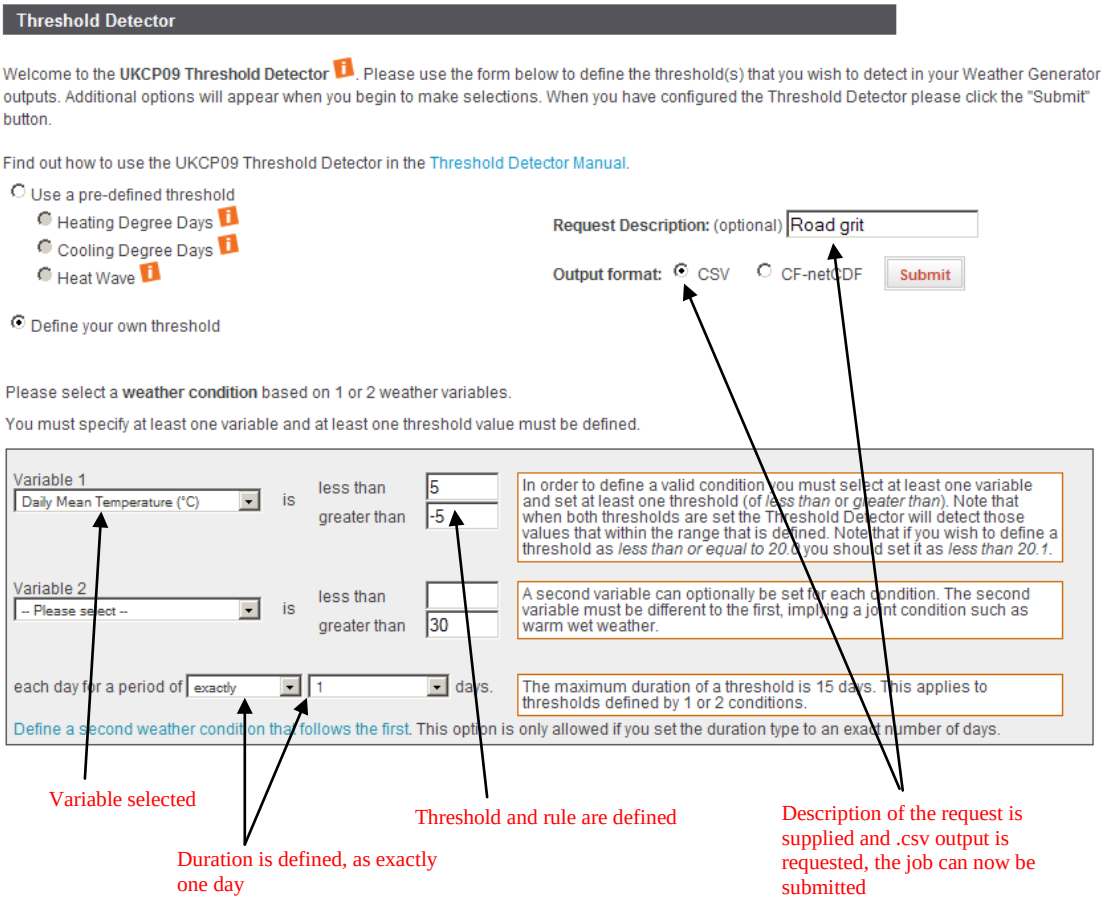


Figure 15. Road gritting event conditions. Note the sign issue when defining the range, to specify an inclusive range, the smaller number (-5), is given in the greater than box, as a number greater than -5 is -4, -3, -2 etc.

Complex event worked example: flash flooding

The occurrence of some natural phenomena are closely related to antecedent conditions, such as flash flooding events, which often arise as a result of a prolonged period of dryness, and warm temperatures, followed by a very intense rainfall event. Prolonged dry spells will result in the soil becoming dry and hard, such that subsequent intense rainfall is unable to infiltrate the hard ground quickly enough, and thus water drains off the land surface rather than through the soil, thus contributing to flash flooding events. Such combinations of weather conditions can be investigated with the threshold detector to investigate possible changes to the occurrence of such combinations of events in the future e.g. precipitation less than 0.1 mm/day and daily maximum temperature greater than 25°c for exactly 14 days, followed by one day of precipitation of 40mm/day. This is illustrated in figure 16 below:

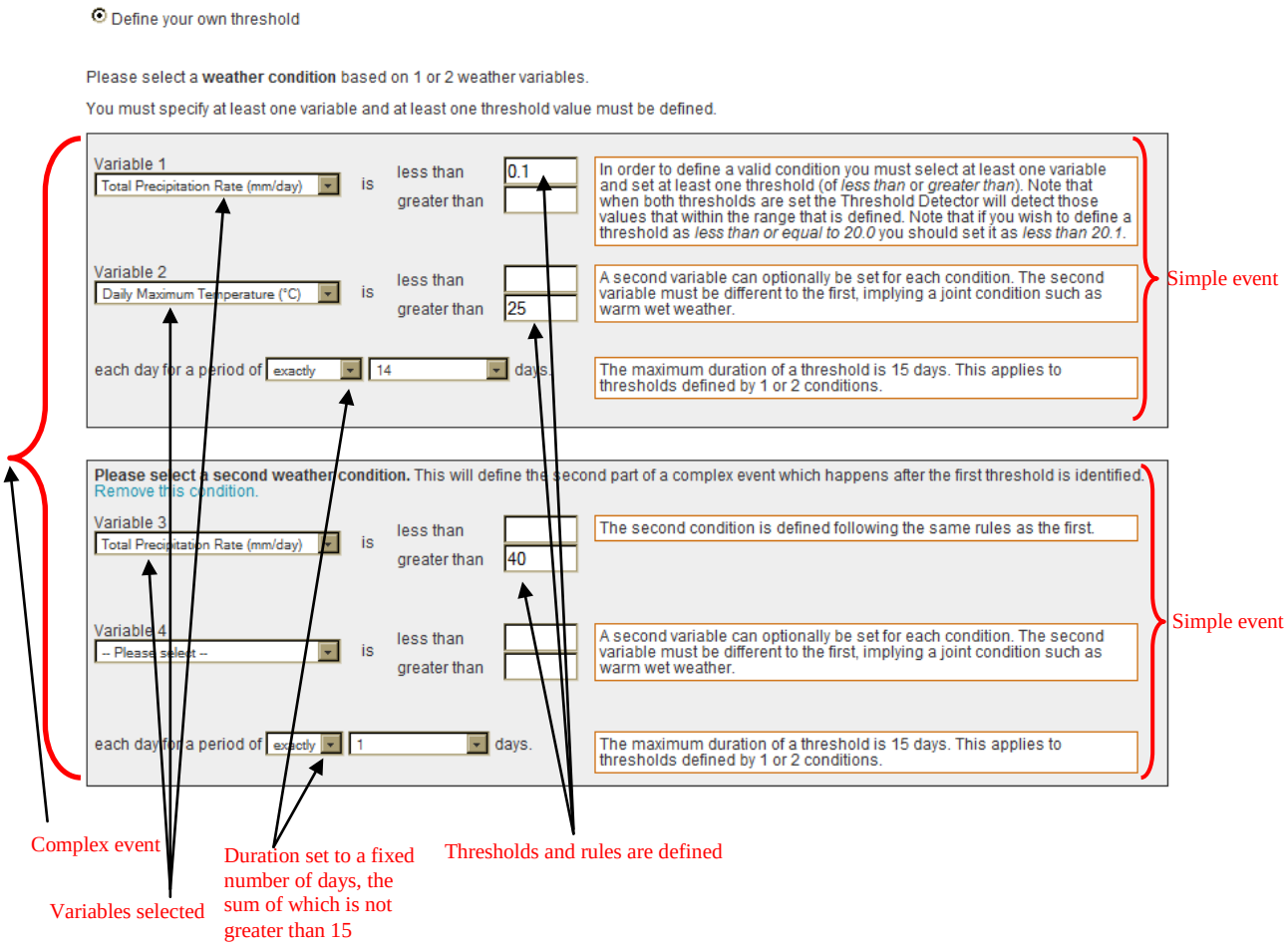


Figure 16. Complex event configuration in the threshold detector, in this case representing conditions that might relate to episodes of flash flooding. Note that the sum of the durations for the complex event cannot be greater than 15 days.

4 Threshold Detector Outputs

Having run the threshold detector it is possible to download the data, and visualise the results.

4.1 Data outputs and file structures

Having run the threshold detector, the data can be downloaded by clicking on the name of the job in the Jobs page of the User Interface, and downloading the data as illustrated in figure 7, a .zip archive file will be downloaded.

4.1.1 .zip archive file contents

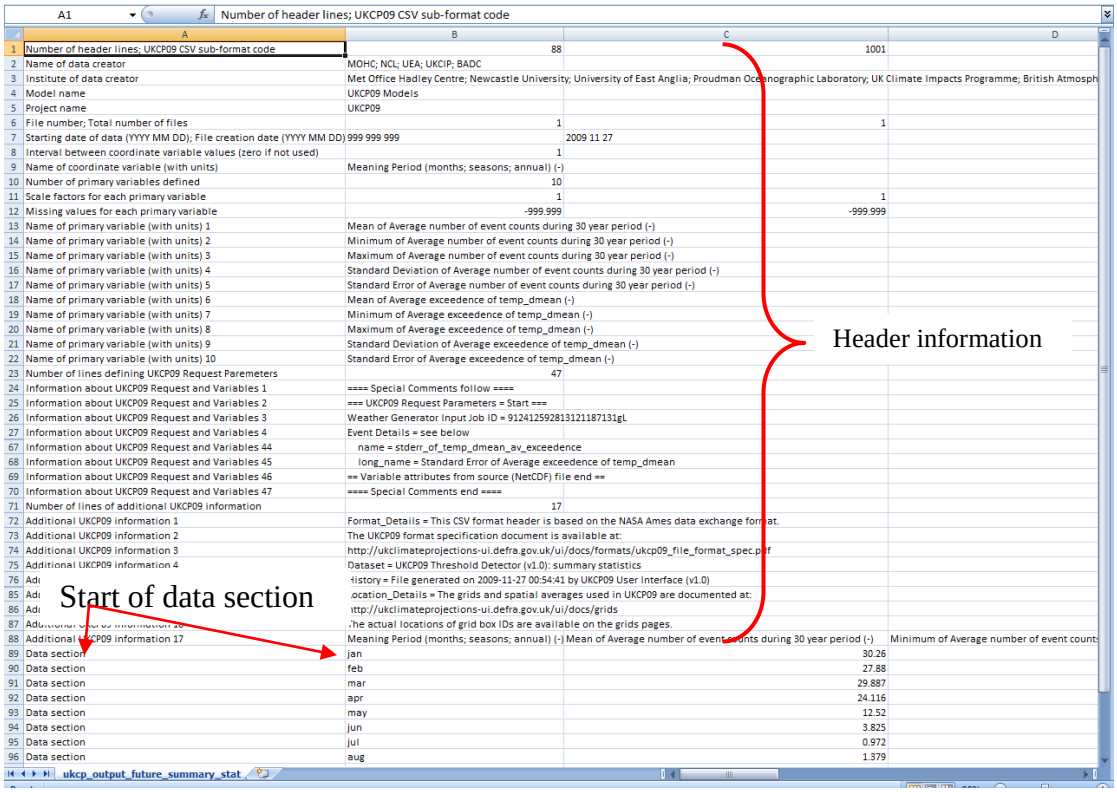
The .zip archive file contains seven text files, described in table 1 below. Depending on how the TD job was set up, and the output file format requested, the files that will be downloaded will either contain files with the .csv file extensions if the comma separated values file option was selected; or files with extension .nc if the CF-netCDF option was selected. Only the .csv file structure is described in this document.

Table 1. Description and contents of the files in the .zip archive downloaded from the threshold detector.

File	Description
copyright.txt	This file contains the copyright declaration that relates to UKCP09 outputs.
metadata.xml	This file contains details of some of the request parameters, such as the conditions specified, duration, and data output format.
source_wg_job_metdata.xml	This file contains details of the parameters that were used in defining the original weather generator job, that the threshold detector has been run on, e.g. time period, emissions scenario.
ukcp_output_baseline_output.csv (.nc if CF-netCDF was selected)	This file contains outputs that relate to each of the 100 simulations or runs with the weather generator for the baseline period. The structure of these files is described in section 4.1.4 below.
ukcp_output_baseline_summary_stats.csv (.nc)	This file contains summary statistics for the baseline period, relating to the 30 year time period for which the weather generator has been run. These summary statistics files are described in more detail in section 4.1.3 below.
ukcp_output_future_output.csv (.nc)	This file contains outputs that relate to each of the 100 simulations or runs with the weather generator for the future time period. The structure of these files is described in section 4.1.4 below.
ukcp_output_future_summary_stats.csv (.nc)	This file contains summary statistics for the future time period, relating to the 30 year time period for which the weather generator has been run. These summary statistics files are described in more detail in section 4.1.3 below.

4.1.2 Comma separated values (.csv) file structure

All of the comma separated values (.csv) files are structured in the same way. They consist of a header (or metadata) containing a variable number of lines, with details of how the data were generated (threshold event investigated, weather conditions etc). This header describes the way in which the data is structured, and the various variables contained in the file. The header is then followed by a data section which contains the actual data from the threshold detector analysis. This structure is illustrated in figure 17. Whilst there are differences in the way the data section is structured between the different files (summary statistics and output file), the header structure is consistent between output types (though clearly the number and names of the variables described will vary). Differences between the data sections of the summary statistics and output files are described in section 4.1.3 and 4.1.4 below.



	A	B	C	D
1	Number of header lines; UKCP09 CSV sub-format code	88	1001	
2	Name of data creator	MOHC; NCL; UEA; UKCIP; BADC		
3	Institute of data creator	Met Office Hadley Centre; Newcastle University; University of East Anglia; Proudman Oceanographic Laboratory; UK Climate Impacts Programme; British Atmosph		
4	Model name	UKCP09 Models		
5	Project name	UKCP09		
6	File number; Total number of files	1	1	
7	Starting date of data (YYYY MM DD); File creation date (YYYY MM DD)	999 999 999	2009 11 27	
8	Interval between coordinate variable values (zero if not used)	1		
9	Name of coordinate variable (with units)	Meaning Period (months; seasons; annual) (-)		
10	Number of primary variables defined	10		
11	Scale factors for each primary variable	1	1	
12	Missing values for each primary variable	-999.999	-999.999	
13	Name of primary variable (with units) 1	Mean of Average number of event counts during 30 year period (-)		
14	Name of primary variable (with units) 2	Minimum of Average number of event counts during 30 year period (-)		
15	Name of primary variable (with units) 3	Maximum of Average number of event counts during 30 year period (-)		
16	Name of primary variable (with units) 4	Standard Deviation of Average number of event counts during 30 year period (-)		
17	Name of primary variable (with units) 5	Standard Error of Average number of event counts during 30 year period (-)		
18	Name of primary variable (with units) 6	Mean of Average exceedence of temp_dmean (-)		
19	Name of primary variable (with units) 7	Minimum of Average exceedence of temp_dmean (-)		
20	Name of primary variable (with units) 8	Maximum of Average exceedence of temp_dmean (-)		
21	Name of primary variable (with units) 9	Standard Deviation of Average exceedence of temp_dmean (-)		
22	Name of primary variable (with units) 10	Standard Error of Average exceedence of temp_dmean (-)		
23	Number of lines defining UKCP09 Request Paremeters	47		
24	Information about UKCP09 Request and Variables 1	==== Special Comments follow ====		
25	Information about UKCP09 Request and Variables 2	=== UKCP09 Request Parameters = Start ===		
26	Information about UKCP09 Request and Variables 3	Weather Generator Input Job ID = 9124125928131211871 31gL		
27	Information about UKCP09 Request and Variables 4	Event Details = see below		
67	Information about UKCP09 Request and Variables 44	name = stderr_of_temp_dmean_av_exceedence		
68	Information about UKCP09 Request and Variables 45	long_name = Standard Error of Average exceedence of temp_dmean		
69	Information about UKCP09 Request and Variables 46	== Variable attributes from source (NetCDF) file end ==		
70	Information about UKCP09 Request and Variables 47	==== Special Comments end ====		
71	Number of lines of additional UKCP09 information	17		
72	Additional UKCP09 information 1	Format_Details = This CSV format header is based on the NASA Ames data exchange format.		
73	Additional UKCP09 information 2	The UKCP09 format specification document is available at:		
74	Additional UKCP09 information 3	http://ukclimateprojections-ui.defra.gov.uk/ui/docs/formats/ukcp09_file_format_spec.pdf		
75	Additional UKCP09 information 4	Dataset = UKCP09 Threshold Detector (v1.0): summary statistics		
76	Ad	History = File generated on 2009-11-27 00:54:41 by UKCP09 User Interface (v1.0)		
85	Ad	Location_Details = The grids and spatial averages used in UKCP09 are documented at:		
86	Ad	http://ukclimateprojections-ui.defra.gov.uk/ui/docs/grids		
87	Ad	The actual locations of grid box IDs are available on the grids pages.		
88	Additional UKCP09 information 17	Meaning Period (months; seasons; annual) (-)	Mean of Average number of event counts during 30 year period (-)	Minimum of Average number of event counts
89	Data section	jan	30.26	
90	Data section	feb	27.88	
91	Data section	mar	29.887	
92	Data section	apr	24.116	
93	Data section	may	12.52	
94	Data section	jun	3.825	
95	Data section	jul	0.972	
96	Data section	aug	1.379	

Figure 17. A csv file opened in a spreadsheet software package, illustrating the main structure of the files that can be downloaded from the threshold detector.

Both the summary statistics and the future and baseline output files will contain various statistics relating to **the number of days when the threshold event was exceeded** (a count of the number of threshold events) and **the amount that the threshold (or weather condition) is exceeded** (expressed in units of the particular variable of interest).

For each file (both the summary statistics file, and output file), the statistics are presented for each of the 17 meaning periods, which are:

- The **twelve calendar months** of the year: January, February, March, April, May, June, July, August, September, October, November, December.
- The **four seasons**: winter (composed of December, January, February (DJF)), spring (March, April, May (MAM)), summer (June, July, August (JJA)), and autumn (September, October, November (SON)).
- **Annually**.

4.1.3 Standard output file details

	A	B	C	D	E	F
69	Additional UKCP09 information 17	Meaning Period =	Total number of event counts during 30 year period	Total exceedence of temp_d max	Average number of event counts during 30 year period	Average exceedence of temp_d max
70	Data secti	0	17			
71	Data secti	jan	0	0	0	0
72	Data secti	feb	0	0	0	0
73	Data secti	mar	0	0	0	0
74	Data secti	apr	0	0	0	0
75	Data secti	may	76	148.82	2.533	4.961
76	Data secti	jun	260	636.09	8.667	21.203
77	Data secti	jul	928	7560.48	30.933	252.016
78	Data secti	aug	639	1876.66	21.3	62.555
79	Data secti	sep	310	716.99	10.333	23.9
80	Data secti	oct	14	16.8	0.467	0.56
81	Data secti	nov	0	0	0	0
82	Data secti	dec	0	0	0	0
83	Data secti	djf	0	0	0	0

Figure 21 Example summary output file (ukcp_output_future_output.csv)

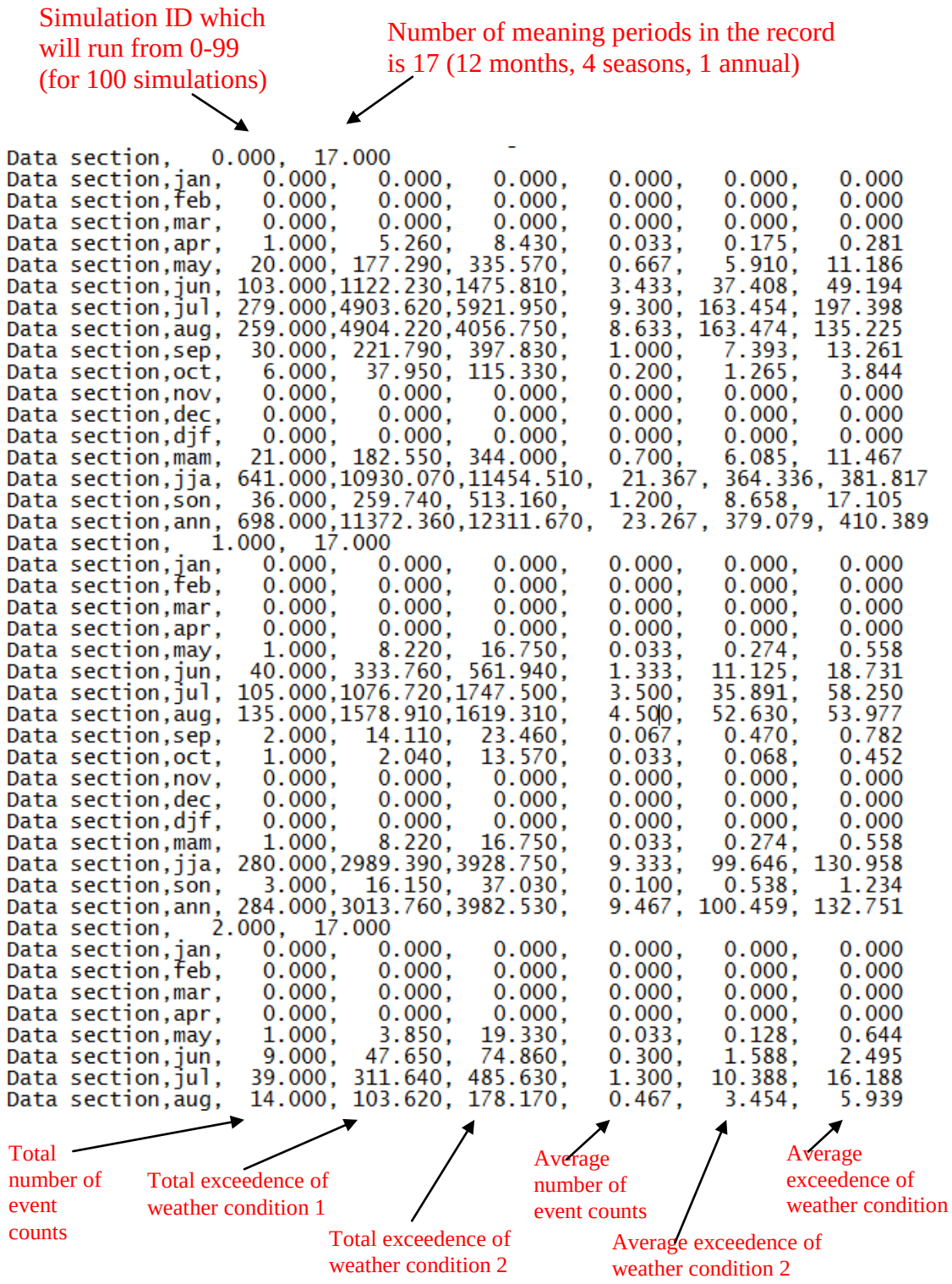
The output file (for both the baseline and future), contains information relating to the **total and average number of counts** of the particular threshold event, and the **total and average exceedence of that threshold (or weather condition(s))**. In contrast to the summary statistics file, the output files contain information relating to each individual simulation (there will be 100), as illustrated in figure 19 below.

In the example in figure 19 below, a threshold event was defined as maximum temperature greater than 25°c and minimum temperature greater than 12°c for exactly three days. With reference to figure 19, we can see that in the first simulation (ID of 0), the incidence of such events only occurred in the months April through to October, with a peak of 279 in July. This number relates to the total number in July over that 30 year period, such that with reference to column 4 of the data, we can see that there were on average 9.3 such events in July of this 30 year time period (which is calculated as 279/30 as there are 30 years of data). This means that this event would occur on average 9.3 times in July of the future climate simulated by the weather generator. Similar values are provided for the seasons and an annual value, the seasons are the averages of the monthly averages for that season, and the annual figure is a sum of the seasonal numbers.

The total exceedence of the threshold event (or weather condition) is reported in column 2 of the data. In the case illustrated in figure 19, this is the total exceedence of maximum temperature above 25°c, and in column 3 the total exceedence of minimum temperature above 12°c. These values are the total amount above the threshold, so if the maximum temperature on one particular day was 29°c then the exceedence for that day would be 4°c (29-25), which, summing for all days in a month for the 30 year period gives the total exceedence. Columns 5 and 6 of the data report the average exceedence of each weather

condition, which is simply the total exceedence divided by 30. A non-zero exceedence is only reported when an event has been detected. So, for example, in July of simulation ID 0, the total exceedence of maximum temperature greater than 25°c, is 4903.620°c, which translates into an average of 163.454°c for July in the future climate simulated by the weather generator. This information might be useful because every degree above of exceedence requires a certain amount of resource to offset.

Again, it should be noted that when a range condition (e.g. between 5 and -5 degrees) has been specified in the threshold detector, the exceedence won't be recorded in the output file. This is because the threshold can be exceeded both positively and negatively, e.g. a positive exceedence of 5 added to a negative exceedence of 5 would result in a cumulative exceedence of 0, and the result would be meaningless.




```
Data section,   0.000,  17.000
Data section,jan,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,feb,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,mar,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,apr,   1.000,   5.260,   8.430,   0.033,   0.175,   0.281
Data section,may,  20.000, 177.290, 335.570,   0.667,   5.910,  11.186
Data section,jun, 103.000,1122.230,1475.810,   3.433,  37.408,  49.194
Data section,jul, 279.000,4903.620,5921.950,   9.300, 163.454, 197.398
Data section,aug, 259.000,4904.220,4056.750,   8.633, 163.474, 135.225
Data section,sep,  30.000, 221.790, 397.830,   1.000,   7.393,  13.261
Data section,oct,   6.000,  37.950, 115.330,   0.200,   1.265,   3.844
Data section,nov,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,dec,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,djf,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,mam,  21.000, 182.550, 344.000,   0.700,   6.085,  11.467
Data section,jja, 641.000,10930.070,11454.510,  21.367, 364.336, 381.817
Data section,son,  36.000, 259.740, 513.160,   1.200,   8.658,  17.105
Data section,ann, 698.000,11372.360,12311.670,  23.267, 379.079, 410.389
Data section,   1.000,  17.000
Data section,jan,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,feb,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,mar,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,apr,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,may,   1.000,   8.220,  16.750,   0.033,   0.274,   0.558
Data section,jun,  40.000, 333.760, 561.940,   1.333,  11.125,  18.731
Data section,jul, 105.000,1076.720,1747.500,   3.500,  35.891,  58.250
Data section,aug, 135.000,1578.910,1619.310,   4.500,  52.630,  53.977
Data section,sep,   2.000,  14.110,  23.460,   0.067,   0.470,   0.782
Data section,oct,   1.000,   2.040,  13.570,   0.033,   0.068,   0.452
Data section,nov,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,dec,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,djf,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,mam,   1.000,   8.220,  16.750,   0.033,   0.274,   0.558
Data section,jja, 280.000,2989.390,3928.750,   9.333,  99.646, 130.958
Data section,son,   3.000,  16.150,  37.030,   0.100,   0.538,   1.234
Data section,ann, 284.000,3013.760,3982.530,   9.467, 100.459, 132.751
Data section,   2.000,  17.000
Data section,jan,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,feb,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,mar,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,apr,   0.000,   0.000,   0.000,   0.000,   0.000,   0.000
Data section,may,   1.000,   3.850,  19.330,   0.033,   0.128,   0.644
Data section,jun,   9.000,  47.650,  74.860,   0.300,   1.588,   2.495
Data section,jul,  39.000, 311.640, 485.630,   1.300,  10.388,  16.188
Data section,aug,  14.000, 103.620, 178.170,   0.467,   3.454,   5.939
```

Figure 19. Example of the structure of the data section of the output .csv files, containing information relating to the counts and exceedence of the threshold event for each of the 100 simulations from the weather generator. The header part of the .csv file will describe what each of the variables is.

4.1.4 Summary statistics details

The summary statistics data contains information on the *mean*, *minimum*, *maximum*, *standard deviation* and *standard error* of the **number of counts** of the particular threshold event, and the **exceedence** of that threshold (or weather condition), in the 30 year period for which the weather generator has been run. This data section structure is illustrated in figure 18.

It should be noted that when a range condition (e.g. between 5 and -5 degrees) has been specified in the threshold detector, the exceedence won't be recorded in the summary statistics file. This is because the threshold can be exceeded both positively and negatively, e.g. a positive exceedence of 5 added to a negative exceedence of 5 would result in a cumulative exceedence of 0, and the result would be meaningless.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Additional UKCP09 information 17	Meaning Period (months; seasons; annual) (-)	Mean of Average number of event counts during 30 year period (-)	Minimum of Average number of event counts during 30 year period (-)	Maximum of Average number of event counts during 30 year period (-)	Standard Deviation of Average number of event counts during 30 year period (-)	Standard Error of Average number of event counts during 30 year period (-)	Mean of Average exceedence of temp_dmax (-)	Minimum of Average exceedence of temp_dmax (-)	Maximum of Average exceedence of temp_dmax (-)	Standard Deviation of Average exceedence of temp_dmax (-)	Standard Error of Average exceedence of temp_dmax (-)
2	Data secti	jan	0.002	0	0.067	0.009	0.001	0.001	0	0.037	0.005	0
3	Data secti	feb	0.001	0	0.033	0.005	0	0	0	0.02	0.002	0
4	Data secti	mar	0.022	0	0.233	0.045	0.004	0.027	0	0.426	0.067	0.007
5	Data secti	apr	0.105	0	0.967	0.156	0.016	0.136	0	1.946	0.265	0.026
6	Data secti	may	0.897	0	8.133	1.211	0.121	1.39	0	15.129	2.189	0.219
7	Data secti	jun	6.416	0.4	19.1	4.136	0.414	16.447	0.482	65.775	13.765	1.377
8	Data secti	jul	15.317	0.633	31	9.162	0.916	58.437	1.316	389.258	61.602	6.16
9	Data secti	aug	12.13	0.5	30.733	8.806	0.881	37.167	0.585	196.514	39.536	3.954
10	Data secti	sep	3.783	0	23.767	4.656	0.466	8.294	0	80.699	13.109	1.311
11	Data secti	oct	0.34	0	2	0.426	0.043	0.41	0	3.179	0.603	0.06
12	Data secti	nov	0.011	0	0.233	0.033	0.003	0.012	0	0.433	0.049	0.005
13	Data secti	dec	0.051	0	0.267	0.064	0.006	0.087	0	0.643	0.14	0.014
14	Data secti	djf	0.053	0	0.267	0.065	0.007	0.088	0	0.643	0.14	0.014
15	Data secti	mam	1.025	0	9.3	1.277	0.128	1.553	0	17.362	2.328	0.233
16	Data secti	jja	33.863	3.667	68.6	17.732	1.773	112.051	5.354	458.378	89.108	8.911
17	Data secti	son	4.134	0.033	24.267	4.81	0.481	8.715	0.002	81.135	13.268	1.327
18	Data secti	ann	39.076	5.067	88.967	20.785	2.078	122.406	7.234	474.48	95.809	9.581

Figure 18. Example of summary statistics file opened in a spreadsheet software package.

The threshold detector allows users to define a threshold for either "an exact number of days" or a "minimum number of days". The former is classified as a fixed length event and the latter as a varied length event. The next two sections refer to the output file received when a user specifies a) a fixed length event and b) a varied length event.

4.1.4.1 Fixed length events

Example weather condition:
Maximum temperature > 30° for exactly 2 days
These statistics are taken from the 100 files of 30 years of daily data produced by the weather generator.

	A	B	C	D	E	F	G	H	I	J	K	L
89	Additional UKCP09 information 17	Meaning Period (months; seasons; annual) (-)	Mean of Average number of event counts during 30 year period (-)	Minimum of Average number of event counts during 30 year period (-)	Maximum of Average number of event counts during 30 year period (-)	Standard Deviation of Average number of event counts during 30 year period (-)	Standard Error of Average number of event counts during 30 year period (-)	Mean of Average exceedence of temp_d max (-)	Minimum of Average exceedence of temp_d max (-)	Maximum of Average exceedence of temp_d max (-)	Standard Deviation of Average exceedence of temp_d max (-)	Standard Error of Average exceedence of temp_d max (-)
90	Data secti	jan	0	0	0	0	0	0	0	0	0	0
91	Data secti	feb	0	0	0	0	0	0	0	0	0	0
92	Data secti	mar	0	0	0	0	0	0	0	0	0	0
93	Data secti	apr	0	0	0	0	0	0	0	0	0	0
94	Data secti	may	0.004	0	0.067	0.014	0.001	0.005	0	0.197	0.025	0.002
95	Data secti	jun	0.191	0	1.2	0.23	0.023	0.745	0	6.23	1.064	0.106
96	Data secti	jul	0.846	0	6.467	1.262	0.126	3.726	0	37.134	6.515	0.651
97	Data secti	aug	0.888	0	6.067	1.259	0.126	4.082	0	35.05	6.692	0.669
98	Data secti	sep	0.085	0	0.767	0.149	0.015	0.275	0	3.763	0.624	0.062
99	Data secti	oct	0.004	0	0.033	0.01	0.001	0.005	0	0.086	0.016	0.002
100	Data secti	nov	0	0	0	0	0	0	0	0	0	0
101	Data secti	dec	0	0	0	0	0	0	0	0	0	0
102	Data secti	djf	0	0	0	0	0	0	0	0	0	0
103	Data secti	mam	0.004	0	0.067	0.014	0.001	0.005	0	0.197	0.025	0.002
104	Data secti	jja	1.925	0.033	11.4	2.27	0.227	8.554	0.009	58.472	11.724	1.172
105	Data secti	son	0.089	0	0.767	0.15	0.015	0.28	0	3.763	0.628	0.063
106	Data secti	ann	2.018	0.033	11.667	2.34	0.234	8.839	0.132	59.228	11.97	1.197

Figure 19 Example of summary statistics showing fixed length events

For **fixed length events**, the summary statistics are provided for the (i) average number of event counts and (ii) the average exceedences of any meteorological variables that have been recorded in the main TD output files. For any average exceedence recorded in the standard TD output files there will be a set of summary statistics. The resulting column order in a fixed length event file will therefore be:

Column A	"Data section"	
Column B	Meaning period	
Columns C - G	Summary statistics for average number of counts (per-year)	
Columns H – L	Summary statistics for average exceedence of *variable* 1 (per-year)	[Will only appear if recorded in main TD outputs]
Columns M – Q	Summary statistics for average exceedence of *variable 2* (per-year) as for those in columns H-L	[Will only appear if recorded in main TD outputs]
Columns R – V	Summary statistics for average exceedence of *variable 3* (per-year) as for those in columns H-L	[Will only appear if recorded in main TD outputs]
Columns W – AA	Summary statistics for average exceedence of *variable 4* (per-year) as for those in columns H-L	[Will only appear if recorded in main TD outputs]

Note that all the summary statistics for a **fixed length event (both for average number of counts and average exceedence of a variable)** have been calculated from averages derived by dividing the total number of counts over 30 years by 30. This means that they should all be treated as **per-year** values.

4.1.4.2 Varied length events

Example weather condition:
Maximum temperature > 30.9 and minimum temperature >15.9 for event lasting a minimum of 5 days.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Additiona	Meaning f	Mean of Average number of event counts during 30 year period (-)	Minimum of Average number of event counts during 30 year period (-)	Maximum of Average number of event counts during 30 year period (-)	Standard Deviation of Average number of event counts during 30 year period (-)	Standard Error of Average number of event counts during 30 year period (-)	Mean of Counts of event lasting 5 days (-)	Minimum of Counts of event lasting 5 days (-)	Maximum of Counts of event lasting 5 days (-)	Standard Deviation of Counts of event lasting 5 days (-)	Standard Error of Counts of event lasting 5 days (-)	Mean of Counts of event lasting 6 days (-)	Minimum of Counts of event lasting 6 days (-)	Maximum of Counts of event lasting 6 days (-)	Standard Deviation of Counts of event lasting 6 days (-)	Standard Error of Counts of event lasting 6 days (-)
2	Data secti	jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Data secti	feb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Data secti	mar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Data secti	apr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Data secti	may	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Data secti	jun	0.032	0	0.4	0.07	0.007	0.51	0	4	0.99	0.099	0.18	0	6	0.783	0.078
8	Data secti	jul	0.229	0	2.067	0.414	0.041	1.75	0	13	2.595	0.26	1.55	0	9	2.32	0.232
9	Data secti	aug	0.235	0	2.3	0.471	0.047	2.1	0	14	3.371	0.337	1.24	0	11	2.275	0.227
10	Data secti	sep	0.001	0	0.033	0.007	0.001	0.04	0	1	0.197	0.02	0	0	0	0	0
11	Data secti	oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Data secti	nov	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Data secti	dec	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Data secti	djf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Data secti	mam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Data secti	jja	0.496	0	4.367	0.81	0.081	4.36	0	26	5.469	0.547	2.97	0	20	4.044	0.404
17	Data secti	son	0.001	0	0.033	0.007	0.001	0.04	0	1	0.197	0.02	0	0	0	0	0
18	Data secti	ann	0.498	0	4.4	0.813	0.081	4.4	0	26	5.551	0.555	2.97	0	20	4.044	0.404

Figure 20 Example summary output file (ukcp_output_future_summary_stats.csv)

For **varied length events**, the summary statistics are provided for the (i) average number of event counts (as described above) and (ii) the average number of event counts for each event duration (from the minimum length specified to the maximum event length of 15 days).

The resulting column order in a varied length event summary statistics file will therefore be:

Column A:	"Data section"	
Column B:	Meaning period	
Columns C - G:	Summary statistics for average number of counts (per-year)	
Columns H – L:	Summary statistics for counts of events lasting exactly the *minimum length* specified (per 30-years)	
Further columns (in groups of 5)	Summary statistics for counts of events *lasting exactly each duration up to the maximum event length* (per 30-years)	[Calculated for each duration increasing from the minimum length by 1 until the maximum length (15 days). If the minimum length was defined as 15 days then only columns H – L will be populated.]

Note that **columns C – G** in the summary statistics (average number of counts) for a **varied length event** have been calculated from averages derived by dividing the total number of counts over the 30- year period by 30. This means that these values should be treated as **per-year** values. The summary statistics in **columns H onwards** (counts of events lasting the minimum length specified) have been calculated from the total number of counts over thirty years. The content of these columns depends on (i) the event type and (ii) the conditions defined for that event. Values in columns H onwards should be treated as values **per 30-year duration**.

4.1.5 How the outputs and summary statistics are calculated

This section looks in detail at the method for calculating the output files and summary statistics files for both fixed length and varied length events.

1. Since there are 100 WG runs the TD records an array of 100 average values for each month, season and annual counts. There are 12 months, 4 seasons and 1 annual value so the resulting data structure is a 2-dimensional matrix of shape 17 meaning periods x 100 runs. The TD treats each of the 17 meaning periods individually when calculating the summary statistics.

2. The contents of the **standard output files** are calculated as follows:
   - For each individual WG run (and for the baseline and future period), the total number of threshold events that are recorded in each month/season/year is summed. These values are recorded in the standard TD output files, **in column C (Total number of event counts during 30 year period)**.
   - For each individual run, the average number of events per-year is calculated by dividing the total (from column C) by 30. These values are recorded in the standard TD output files, in **column E (Average number of event counts during 30 year period)**.

3. The contents of the **summary statistics files** are calculated as follows:
   C**olumns C – G** is entirely calculated from the 100 averages (see point 1).

   a. The **mean** (reported in **column C** of the summary statistics file) is calculated by summing all 100 average values (for one meaning period) and dividing by 100. **The mean corresponds to the "mean of the average event counts per-year" for that event.**

   b. The **minimum value** (reported in **column D** of the summary statistics file) is simply the lowest value in the average 100 values (for one meaning period).

   c. The **maximum value (**reported in **column E** of the summary statistics file) is the highest value in the average 100 values (for one meaning period).

   d. The **standard deviation** (reported in **column F** of the summary statistics file) is calculated from the average 100 values using the formula:

$$s_N = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2}.$$

   Where $\{x_1, x_2, ..., x_N\}$ are the observed values of the sample items and $\overline{x}$ is the mean value of these observations.

e. The **standard error** (reported in **column G** of the summary statistics file) is calculated from the 100 average values using the formula:

$$SE_{\bar{x}} = \frac{s}{\sqrt{n}}$$

Where $SE_{\bar{x}}$ is the standard error, *s* is the standard deviation and *n* is the total number of samples. In this case there are 100 WG runs so that square root of *n* is always 10. Hence the standard error value will always equal that standard deviation divided by 10.

The remaining content of the summary statistics file depends on whether the TD has recorded a fixed length event or a varied length event.

4.1.6 Interpretation of TD outputs

This section highlights issues that should be noted when interpreting the outputs from the TD. The following issues are covered:

- An explanation of why there can be more total counts of 15-day events than counts of events with a shorter duration
- An explanation of why the maximum of the average seasonal event counts may not equal the summed maxima of the average monthly counts (in the summary statistics outputs)

4.1.6.1 An explanation of why there can be more total counts of 15-day events than counts of events with a shorter duration

The TD has an enforced maximum event length of 15 days. When interpreting the results of varied length events the TD records the total event counts of each duration from the minimum duration (set when the job is configured) up to 15 days. In the case of a minimum event length of 6 days the TD would record counts of events lasting 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 days.

In most cases the number of events lasting the shortest durations is higher than the number of events lasting longer durations. Typically, the number of counts tails off towards the 15-day duration. However, in some cases there is a sudden increase at the 15-day maximum duration. The reason for this is explained below.

Here is an example set of counts of occurrences of drought events in the month of March:

```
 6 days: 10
 7 days:  8
 8 days:  7
 9 days:  8
10 days:  6
11 days:  4
12 days:  3
13 days:  2
14 days:  1
15 days:  4
```

For comparison, it is easier to view these as a simple list:

```
10, 8, 7, 8, 6, 6, 3, 2, 1, 4
```

There are clearly more events recorded of shorter length and this is physically realistic. However, when the TD gets to the 15-day event there is a sudden increase. This looks unrealistic until we understand that the increase is an artefact created by the limiting the maximum event length.

The complete set of counts, with no maximum event length, would actually be as follows:

```
 6 days: 10
 7 days:  8
 8 days:  7
 9 days:  8
10 days:  6
11 days:  4
12 days:  3
13 days:  2
14 days:  1

15 days:  1
16 days:  0
17 days:  1
18 days:  1
19 days:  0
20 days:  0
21 days:  1
```

Note that the total number of events recorded with a duration of 15 days or more is 4. This is equal to the number recorded at the 15-day duration when that was imposed as the maximum event length. From the above figures it is clear that the use of a maximum event length within the TD will cause the count at that maximum duration to include the counts of all events that would last for longer durations. Since the TD is instructed to stop when it reaches the maximum duration it records all longer events at this point (15 days) and starts detecting a new event.

The following example uses the same data as above but imposes a maximum event length of 10 days:

```
 6 days: 10
 7 days:  8
 8 days:  7
 9 days:  8
10 days:  20
```

Once again, events of the maximum duration receive a higher count than you would intuitively expect but it makes sense in light of the explanation above. The 10-day count is actually including capturing the 20 events lasting from 11 to 21 days in length.

4.1.6.2 An explanation of why the maximum of the average seasonal event counts may not equal the summed maxima of the average monthly counts (in the summary statistics outputs)

The maximum and minimum values in the summary statistics are calculated from the 100 average event counts (per-year) as explained in the section above. When viewing the summary statistics it is clear that the means for each season are the sums of the means for the months that make up that season. The annual value is the sum of the seasonal means.

In the case of the maximum and minimum values the seasonal values are **not equal to the sum of the monthly values** that make up that season. This is due to the method used by the TD to calculate the summary statistics. The maximum and minimum values are calculated independently for each month, season and then annual values. The following example provides an explanation.

If we looked at the TD outputs from 2 WG runs only (instead of 100) and examined the June, July, August and summer (JJA) average values the TD might record:

Run 1:	June:	5	July:	5	August:	15	JJA: 25
Run 2:	June:	15	July:	0	August:	3	JJA: 18

When the summary statistics are calculated, each column is treated independently to produce the following results:

Max:	June:	15	July:	5	August:	15	JJA: 25

In this case, the sum of the June, July and August maxima is equal to 35 whereas the summer maximum is only 25. Because of the method used, it is expected that the seasonal or annual maximum will not equal the sum of the monthly maxima.

4.2 Visualising the outputs

Having run the threshold detector it is now possible to gain a quick visual assessment of the changes in the future (and how these compare to the baseline period), by using the UKCP09 visualisation tool. The visualisation tool can be used to plot **changes in the counts** of the particular event, it cannot be used to plot exceedence values. To visualise the outputs follow these steps:

1. From the jobs page of the User Interface, next to the job that you are interested in, click on the Visualise Threshold Detector Output link as illustrated in figure 20 below:

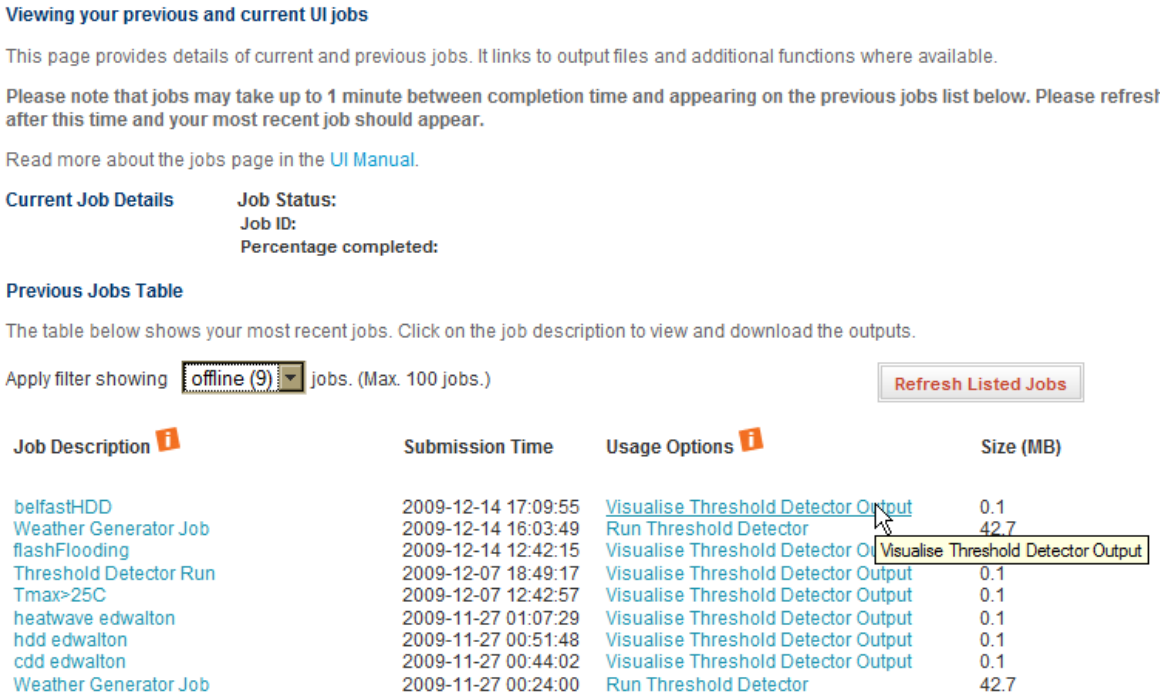


Figure 20. Starting a visualisation of threshold detector outputs by clicking from the main Jobs page of the User Interface.

2. Having clicked this link you will be taken to the main Viewing and Modifying your output page as illustrated in figure 8. By default the results will be displayed by season, but this can be changed along with various other display properties, using the various options available as illustrated in figure 21 below:

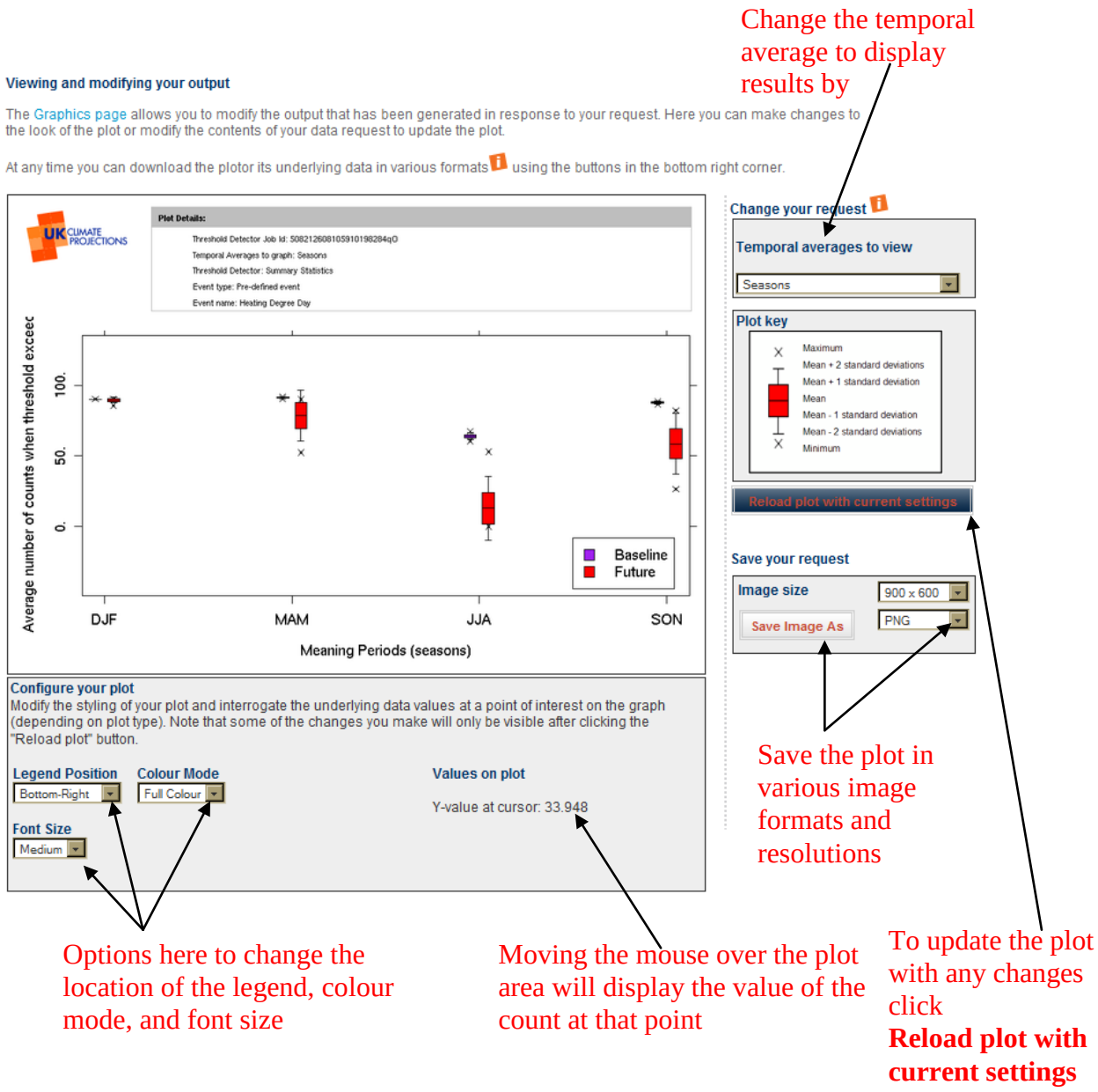


Figure 21. The UKCP09 visualisation tool on the User Interface.

3. The outputs that are plotted are the counts of the threshold event, and are visualised as box and whisker plots with the following statistics associated with the box and whiskers, as illustrated in figure 22.

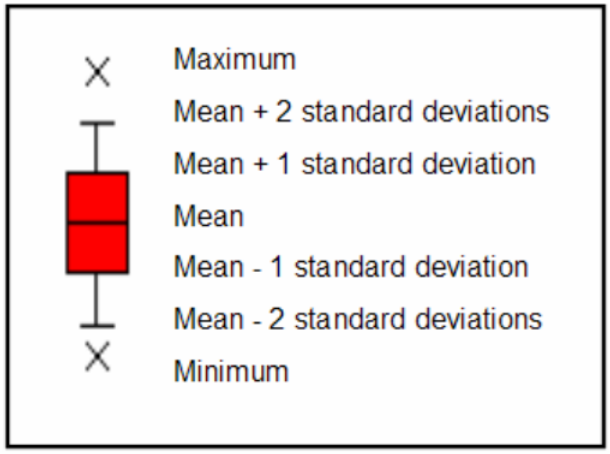


Figure 22. Values indicated by the box-and-whisker levels and extremes markers on the summary statistics plots.

4. It is possible to change the temporal average from the default position of seasons, to months, or months and annual, or seasons and annual. To do so click the temporal average drop-down box and select the desired option, then click the 

button and the plot will be updated.
5. To change the legend position, colour mode (from full colour to greyscale), or font-size, again use the appropriate drop down box, make your selection, and then click the 

button, and the plot will update.
6. To save the plot as a graphic that can be integrated with a report you may be writing, select the image format (.png, .jpeg, .pdf, .ps) and resolution (600 x 400, 900 x 600, 1200 x 800) you would like from the drop down box shown in figure 22, and then click the 

button, and a dialogue box will open containing a link which you can click to download the graphic as a zip file. This zip file will contain the following files in addition to the graphics file(s):

Table 2. Files that are contained in the graphics .zip archive when an image format has been downloaded. The .zip archive will also contain the graphics file(s) in the format requested.

File	Description
copyright .txt	This file contains the copyright declaration that relates to UKCP09 outputs.
metadata.xml	This file contains details of some of the request parameters, such as the conditions specified, duration, and data output format.
source_td_job_metadata.xml	This file contains details of the parameters that were used in defining the threshold event e.g. the data output format, threshold event investigated.
source_wg_job_metadata.xml	This file contains details of the parameters that were used in defining the original weather generator job used to run the threshold detector such as time period and emissions scenario.

Figure 23 below provides an example of the graphical output that can be produced from the User Interface, and integrated into a report.

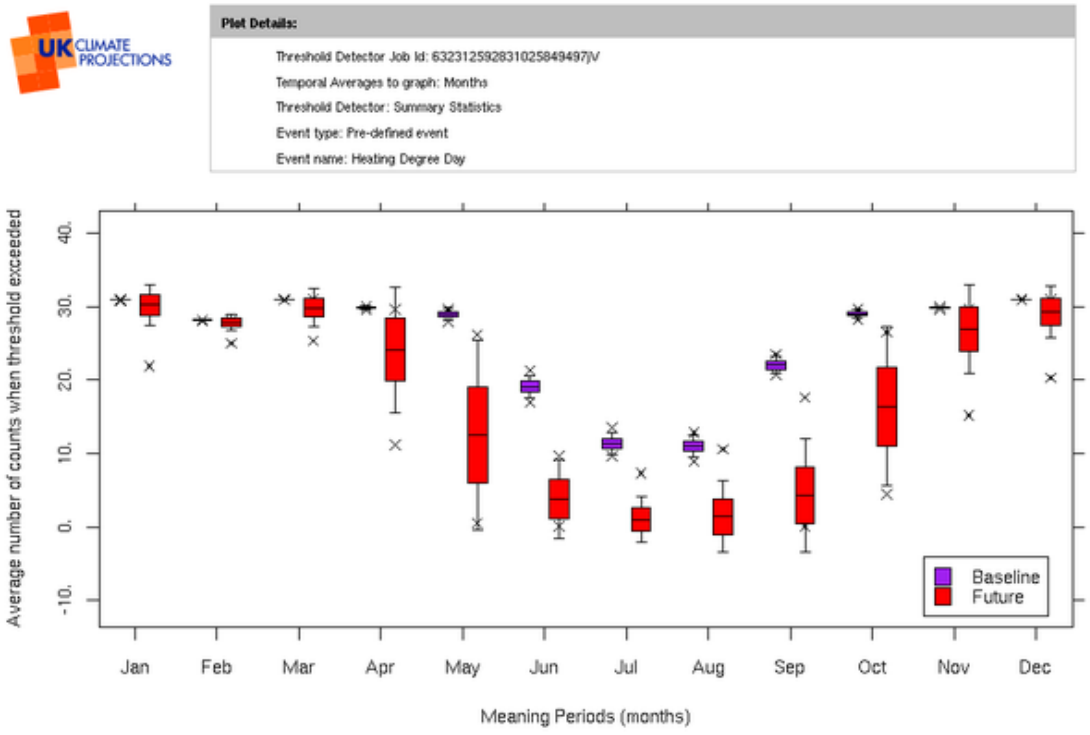


Figure 23. Example graphical output from the threshold detector, in this case investigating possible changes in heating degree days in the 2080s, under a high emissions scenario, for a 5km grid cell in central England.